Australian Model Engineering

November-December 1997

Issue 75

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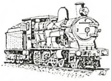
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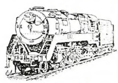
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ME3

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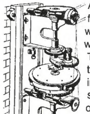
1853 Handbook on abrasion! Sharpen tools, engrave glass, cut gems, grind lenses, much more!

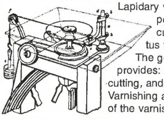
HANDBOOK FOR THE ARTISAN MECHANIC AND ENGINEER
by Oliver Byrne
reprinted by Lindsay Publications
"...comprising the grinding and sharpening of cutting tools, abrasive processes, lapidary work, gem and glass engraving, varnishing and lacquering, apparatus, materials, and processes for grinding and polishing, etc. etc..."
This is an oldie.



Although printed in 1870, the original copyright is from 1853 And this is great how-to, and very well illustrated, at least for that era, with 185 wood engravings.

The section on grinding and sharpening cutting tools includes chapters entitled: grinding cutting tools on the ordinary grindstone, sharpening cutting tools on the oilstone, setting razors, sharpening cutting tools with artificial grinders, and grindstones.

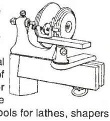
The figuration of materials by abrasion includes: the production of plane surfaces by abrasion, the production of cylindrical surfaces by abrasion, the production of conical surfaces by abrasion, the production of spherical surfaces by abrasion, and glass cutting.



Lapidary work includes: slitting, cutting, and polishing fiat and rounded works; cutting facets; and lapidary apparatus for amateurs.

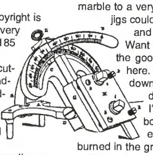
The gem and glass engraving section provides: seal and gem engraving, cameo cutting, and glass engraving.

Varnishing and lacquering covers preparation of the varnishes and application of varnishes.



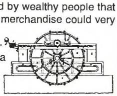
Finally you get a general discussion on abrasive techniques and "*dictionary of the apparatus, materials and processes for grinding and polishing commonly employed in useful arts.*"

There are some very interesting and unusual devices such a ganged saws for slitting a slab of limestone, and another for polishing limestone or marble to a very flat surface. Some of the simple jigs could be used today to grind cutting tools for lathes, shapers and milling machines.



Want to grind a lens to make a telescope so you can spy on the good looking neighbour lady next door? The secrets are here. Better yet, cut and polish that chunk of quartz you found down at the quarry into a beautiful ring. Tell her It's a huge diamond!

I'm sure there have been many improvements since this book first published, but just think of the beautiful jewellery, polished and finery owned by wealthy people that burned in the great Chicago fire of 1871. That merchandise could very well have been produced by this equipment.



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The Cover

Malcolm Harris eases his Sandy River and Rangeley Lakes No.24 into the station after another successful run. The loco looks quite at home among the trees at Luddenham in NSW.

Photo: Brian Carter

Australian Model Engineering

http://www.ameng.com.au

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Comment

Where have all the younger members gone?

It seems that model engineering societies aren't the only ones having difficulty in enticing younger members. There are probably a number of reasons for all this, so there are no simple answers. Some I can think of are:

1. Things are getting much more formalized now than before and young (and not so young) people don't like the paper work and regulation!
2. There are a lot more groups doing things today than (say) 20 years ago. It's a bit difficult being well involved with more than one group at a time, so the newcomers are spread thinly around.
3. Older established groups often tend to be "cliquey". Just because you're "friendly" doesn't mean you don't have this problem. It can show itself in many ways from plain ignoring the newcomer — to not listening, encouraging etc.
4. The current educational system is tending to avoid the more practical aspects of engineering.
5. Steam trains are now only seen in museums or on special trips.
6. The costs for fan trips are now much higher than they were in my school days, when only a few dollars could get you a day behind all sorts of steam power.
7. Model Engineering groups are not a well-known society activity — in this regard AME is the best thing in years. Compare the model railway scene which has gone from minimal local models to a wide variety, not the least reason, I suggest, being the much better public awareness that the Australian Model Railway Magazine has created.
8. I suspect that because of the costs involved young people can't afford to buy a lathe and tool up. For this reason it is more suited to middle aged or those approaching retirement when thoughts drift away from growing families. I only got started because my father bought all the basic gear. I then "grew" it.

I'm sure someone else has some more reasons.

Congratulations on your 10th anniversary — long live AME!

Warwick Allison

To our new reader

If this is your first issue of Australian Model Engineering, welcome!

We hope you'll look forward to the ideas, news and camaraderie in each bi-monthly issue.

One of the great things about our hobby is the way model engineers actively help each other. Unless you live in an isolated community, you'll soon discover who has valuable experience in your field of interest, or who will help you to make a part that's too big for your workshop machinery. Look in the *Club Roundup* section to find a club that's near to you; pay a visit and you'll usually find model engineers who live not too far away. Then you can experience the great fellowship that makes our hobby special.

This magazine is prepared in the same spirit of "model engineers helping each other". About two dozen people put many hundreds of hours work into each issue — all on a voluntary basis — to help model engineers in Australia and New Zealand keep up to date and stay in touch.

We rely on our readers to write articles for us — for the same (non-existent) rate of pay! If you have ideas or techniques that you feel would be interesting to others, please drop us a line. We'll gladly help with preparation of artwork or editing if that's necessary. Most important of all, please support the people who advertise in our magazine. Without them to pay the bills, you wouldn't be reading this!

Brian Carter

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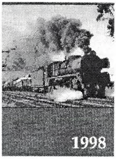
1998 CALENDARS

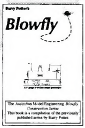
The 1998 calendar is in a totally new format, twice the value, with 13 steam and 13 diesel colour photos, from over four decades of railway photography. Some of Australia's foremost photographers have contributed to make this an outstanding production.



Nostalgic steam scenes (all regular service trains) include, from NSW, Double Garratts blasting up Fassifern bank, 3662+38 on the *Central West Express* on Tumulla bak, 1919 at Darling Island, double Standard Goods leaving Cowra; from Victoria, a J on a Maryborough-Ararat goods, R719 blasting out of Dimboola; from SA, 401 pounding up Belalie bank, 601 in Ellen St, Port Pirie in 1951; from Tasmania, Mt Lyell No.3 at Dubbil Barril; from WA, V1204 dropping down from Collie; and from Queensland, maroon Garratt 1004 at Rockhampton and a C17 on the Brisbane Valley goods.

Diesel gems (again, all regular trains) come from NSW, Bicentennial 8040 and 42218 on a Tahmoor coalie, 4837 on the Bombala goods, 42220 on SL16 Griffith pass at Junee; from Victoria, West Coast B61 on an all-WCR liveried express at Geelong, BL31 and C509 climbing out of Ballarat, immacu late blue and gold S311 on a goods at Springhurst; from SA, 900 *Lady Norrie* a week old at Pt Pirie, double 600s nearing Peterborough, double NRs heading out of Pt Augusta at Yorkey's Crossing, EL51, AL21 and 603 amid the Salvation Jane at Mambray Ck, beautiful CLP14 in the sun's last rays on the *Overland*, and narrow-gauge Brill 106; from Queensland, giant GE 3833 on the *Sunlander*.

All this, 26 top-quality colour photos of trains in regular service throughout Australia over a span of 46 years. The new format is 380mm x 280mm, spiral bound on top-quality, glossy paper, **all for only $16.00 each posted** direct from AME Retail. Double the contents — double the value!



422 class loco drawings
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Golden Arrow (steam launch) drawings 1:1 scale
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Videos

South African Winter Steam $44.95
A look at reopened narrow gauge ex South African line in the east of the country and various Garratts hauling heavy coal trains on private colliery lines. This video contains brilliant scenery being traversed by "soon to be history" commercial steam workings, all filmed in the spectacular winter months. Running time - 55 minutes.

Steam Fever $44.95
Another South African video which looks at various aspects of mainline operations in the final days of steam, including "Red Devil" and a look at the Class 25 condensing locomotive - described as the "last ship of the desert." Many dramatic steam scenes are included along with the day-to-day activities of the crews which worked what must be described as one of the most modern steam systems running on 3'6" gauge in the world.

Superlatives In Steam $44.95
Shows some of the worlds largest steam locomotives in preserved working order on U.S. railways. Video includes shots of Nickel Plate Berkshire 2-8-4 no.765, Norfolk and Western 'J' Class 4-8-4 no.611 and Norfolk and Western 'A' class Mallet no.1218, said to be the most powerful steam locomotive still in working order in the world. Each of these three locos weigh in excess of 400 tons and are shown running full trains on fully commercial lines. Scenes on the footplate during running and detailed segments of the two year restoration of 1218 are also included.

Challenger Through The Rocky Mountains $44.95
This video records the 1991 trip across the US by Union Pacific 4-6-6-4 Challenger no.3985 and 4-8-4 Northern No. 844 from Wyoming to Sacramento, California. Many memorable shots are included particularly in the Rocky Mountains with their snowy backdrop. Cold conditions add to the spectacle of preserved super power at work.

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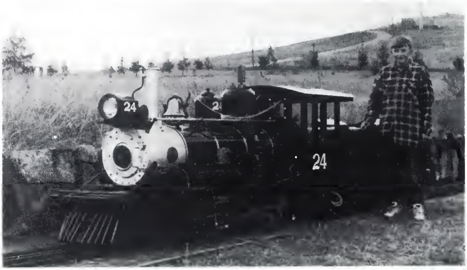
S.R.&R.L. No.24 in 7¼" gauge

by Malcolm Harris

photos by the author unless otherwise indicated

Side view of Malcolm's 7¼" gauge No.24

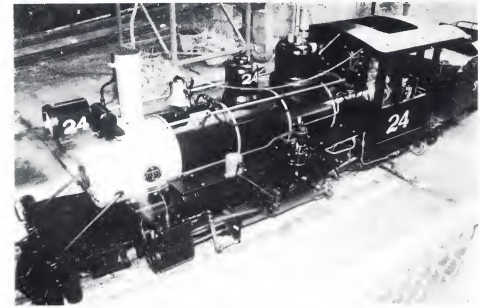
The inspiration for this project came from reading through a book called *2 foot Steam Pictorial* which features the Sandy River and Rangeley Lakes railroad. I liked the look of the locomotive and with detailed general arrangement drawings were in the book how could I refuse! I found detailed drawings of the valve gear in *Live Steam* magazine. The scale for the 2-6-2 No.24 works out at 3⅝" to the foot — or 1:3.3.



Malcolm's son Warren standing next to the 1:3.3 scale loco — big isn't it!

The locomotive

The frames were cut 200mm x 25mm flat steel bar. The axleboxes are cast iron but fitted with roller bearings for more reliable service. The suspension system copies the prototype and is fully compensated. Walschaerts valve gear is used to operate the slide valves on the 88.9mm diameter by 101.6mm stroke cylinders. The cylinder cocks are steam operated. To minimise the work on patternmaking and castings, I decided to use as many castings from the Wato *Sweet Creek* locomotive as I could.



No.24 on revenue duty at the Sydney Society of Model Engineer's track at Luddenham NSW.
Photo: Brian Carter

The Briggs steel boiler shell is 273mm diameter. There is plenty of steam available to lift the two safety valves at 700kPa.

I decided to fit working butterfly doors to the fire hole. It makes firing a bit easier and more like the prototype. To ensure adequate lubrication two systems are used. One is mechanical and the other is hydrostatic. Either can be used so that in the event of a failure, the other system can be brought on line.

Steam is used to operate the engine brakes and compressed air is used for the train brakes. Compressed air is generated just how it should be — from the Westinghouse pump mounted on the side of the boiler.

Tender

The tender body is fabricated from 3mm mild steel plate.

Continued on page 56...

MEANZ

by Bill Chalmers

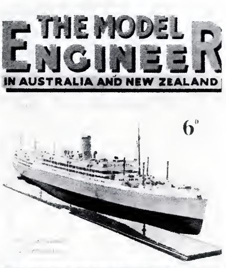
Just what does that cryptic title mean? Well, it goes back a long way, to November 1935, in fact.

That was when the first issue of what was arguably the first serious model engineering magazine produced in Australia went on sale. It was *The Model Engineer in Australia and New Zealand* and thirty eight monthly issues appeared before publication ceased with the issue of February 1939.

The editor was my father, the late A. M. Chalmers. His given names were Alexander Mar (Mar was, and is, a family name) but he used A. Mar Chalmers as Editor of the journal. This has caused a little confusion in later years, when some had the idea that "Mar" was part of the surname. Not so, me hearties!

Volume 1 No. 1 must have created a good impression for those early years, appearing as it did in 270mm by 215mm format, the forerunner of the modem A4 used for AME, and with a colour cover portraying a builder's model of the Orient liner *Orion*. The cover also stated that full working drawings for the model were inside. This was somewhat optimistic by today's standards, as the drawings consisted of a builder's sheer plan and side elevation, a half deck plan and a body plan, intended for a model of 1⁄8 inch to the foot scale, for a model about seven feet long (2200mm).

Three pages of this first issue were devoted to the official opening of the Sydney Society of Model Engineers' new clubhouse at their grounds in Parramatta Road, Ashfield, some 10 kilometres from the centre of Sydney. The opening was performed by the then Govemor of New South Wales, HE Brigadier-General Sir Alexander Hore-Ruthven and the President was Mr J.W. Mann, father of well-known Sydney model engineer, John Mann. Another identity was the Secretary, the late Mr C.S. McKellar, whose son Alan is another Sydney model engineer. Judging from the photos, the crowd must have been at least one thousand strong a not bad for the population of the mid-thirties! I believe I was present with my parents but certainly have only the faintest of memories, being not quite five years old!



The first issue.

Other articles included radio control of models and a report of a claimed world record speed record of 44.99miles per hour for the metre-class flash steam speedboat *Whirlwind*, built by Ron Cowen. Also appearing was the start of a series on building an Australian Pacific for 2½ inch gauge, based on the L.B.S.C. Fayette design. The author was Steam Chest — this may have been Mr McKellar, but I am open to correction on this. I think several were built and ran successfully. During 1938 another series appeared, being the construction of a 2½ inch gauge NSWGR P class 4-6-0, described by N.C.L, who was definitely Mr McKellar. The *Iron Duke*, a NSWGR outline 4-4-2 with Walschaert valve gear, also appeared in 1938 and this was to cause some initially terse letters from the redoubtable LBSC, who claimed that the design was a copy of his GNR-based *Maisie* Atlantic. In fact, there were numerous differences, as those who know the *Iron Duke* built by the late George Farkas will realize.

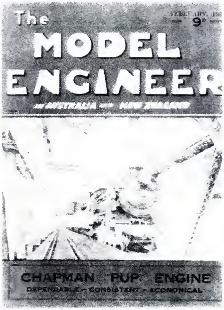
Other contributors over the years included John Buckland, M.A.(Mal) Park and C.C. Singleton, all early Australian Railway Historical Society members, C.A. (Con) Cardew, then Chief Test Engineer of NSWGR and later, Assistant CME (a close family friend) and Gordon Schultz, later to be a member of Surrey Hills Steam Locomotive Society and its descendent, SLSV. Copyright not being so closely observed as it is today, a certain amount of plagiarizing was not uncommon and MEANZ was no exception. Some articles were certainly taken from contemporary publications, by agreement in most cases, I think.

Present-day hobby magazine readers who feel that they are hard done by when a cover price increase comes along should not feel too badly. The cover price of MEANZ was sixpence (5 cents) in 1935, with an annual subscription of five shillings and sixpence (55 cents). The annual sub was probably almost one day's pay on the then equivalent of average weekly eamings, which would make it about $75.00 in today's money. As the editor pointed out in the issue of April-May 1938, however, the magazine was running at loss, so a price increase was necessary. This took the cover price to ninepence, about 8 cents, and the annual sub to nine shillings, or 90 cents.

The magazine folded early in 1939, the last issue being that of February. No waming was given in that issue, but funds were just not available to make the March issue possible. So passed into history a valiant effort to produce a magazine designed for the Australian and New Zealand model engineer and model-maker. In this it was at least partly successful. Today we have AME, a worthy and high-quality successor. Long may it continue!

A. Mar Chalmers was born in January 1901, the eldest son of Scottish parents, Thomas Chalmers and Lillian Chalmers (Marr). His birth was registered in Manchester but family lore is that he was actually born in Scotland. He lived in Sandbach, Cheshire, before migrating to Sydney in 1928, where he subsequently met and married my mother Doris Price (now living in Canberra). Later, his parents and younger brother and sister followed him to settle in NSW. His background in the UK was that of radio engineer, being a sales engineer for the Mullard Valve Company. An attempt to establish a radio and electrical business in Sydney failed with the onset of the Great Depression of the late twenties-early thirties and this was a financial setback, as it was for so many in those days. He became a professional model maker, and some examples I remember include the building of a 1:72 model of the coking ovens of BHP Newcastle, working dioramas for the Vacuum Oil Company (now Mobil) stand at the Sydney Royal Easter Show, models for the Colonial Sugar Refinery and various ship models for shipping companies. His work was of a high standard; I still have some odd examples.

Alex Chalmers was not strictly a model engineer, but rather a professional model-maker. His work in this area probably helped to keep the magazine going as long as it did, I don't think that it was ever profitable, but was an attempt to provide a reasonable magazine by the standards of the day, and in that I feel it wasn't a bad effort. Of course, I'm rather biased!



The final issue.

Spotswood Pumping Station

compiled by Dave Harper from notes by Matthew Churchward and Kevin Eisfelder

Photos and captions by Kevin Eisfelder

The history of the Spotswood Pumping Station began in 1889 when the eminent English sewage engineer James Mansergh was commissioned by the Victorian Government to investigate and report on the possibilities for an underground sewerage system to serve Melbourne and its suburbs. In his report Mansergh proposed the construction of two systems of trunk sewers converging on separate outfall pumping stations at South Yarra and Stoney Creek (Spotswood).

The Metropolitan Board of Works was formed by Act of Parliament in December 1890, and immediately began finalising plans for the new sewerage system. Due to financial constringency of the period, the final system adopted involved the construction of a single enlarged pumping station at Spotswood. The installation comprising of twelve oval pumping wells 15ft x 27ft x 60ft deep, in two engine houses — each of which would eventually house six 300 horsepower steam engines. Additional space was allowed on the site for the extension of the pumping station to a total of 20 wells, but this was never required.

Photo 1. General view of the North engine house, looking South, taken from the platform around Number 9. Going anti-clockwise on the right is Number 10, two electric motors first installed in 1937 over well 10, Number 8 and just visible Number 7. 1/15 sec on 400 ASA.

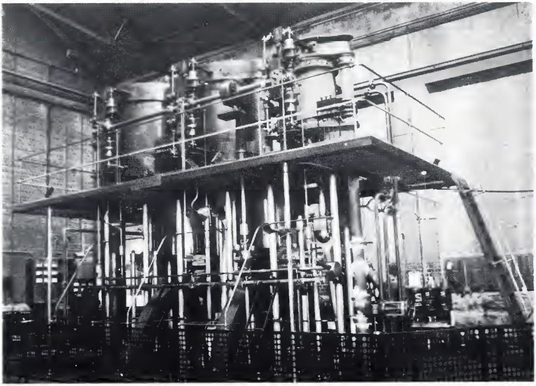


Photo 2. Number 8 pumping engine over number 8 well. Manufactured by The Austral Otis Engineering Company Limited in South Melbourne in 1911. The photo was taken using a tripod and time exposure on 100ASA film.

The Thompson contract

In 1893 Messrs Thompson & Co., of Castlemaine, were awarded a £38,926 contract to manufacture pumping plant for the station against strong competition from other leading English, American and local engineering firms. This initial contract included four 300 horsepower Worthington-type duplex vertical triple-expansion direct-acting condensing steam

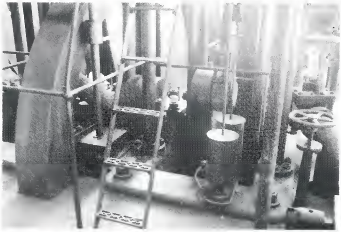


Photo 3. Part of the bed frame of the Hathorn Davey engine (number 5) and the end crank of the high pressure cylinder. The Hathorn Davey engine has four main bearings for the crankshaft, the Austral otis engines having six. f3.5 1/4 sec on 400 ASA.

Photo 4. Corliss valves. These are from the low pressure cylinder of engine Number 7. The valve on the right is the admission valve and the one next to it is an exhaust valve. Both valves are about 6" diameter, the admission valve about 4'11" long the exhaust 4'4" long. The slot in the end of the admission valve is where it obtains its semi rotary motion. (The white stick is a twelve inch rule). f3.5 1/4 sec on 400 ASA.

engines, six 160psi internally-fired return-tube boilers, a Green's economiser and a host of other items such as steam operated penstock valves, receivers and associated pipe work. In order to undertake the contract, Thompson & Co. had to make extensive additions to their own workshop equipment, including the installation of a Siemens electric lighting plant which allowed work to continue around the clock.

The four Thompson steam engines and their boilers were commissioned during February and March 1897, and on 10 August of the same year, the All England Hotel at Port Melbourne became the first property to be connected to the sewerage system. The pumping station was officially opened on 5 February 1898 when Lord Brassey, the Governor of Victoria, ceremoniously raised the main penstock valve.

The Thompson engines were of an unusual design with each unit actually consisting of a pair of triple-expansion engines, with the low-pressure cylinder piston rods direct-coupled to two pump plungers and the intermediate and high pressure cylinders in tandem direct-coupled to two further pump plungers. Although they were able to meet the specified duty, the coal consumption of these engines was higher than expected and their performance was never entirely satisfactory, even after the Austral Otis Engineering Co. supplied modified pump casings, valves and delivery chambers in 1900-1. In light of this it is surprising that the last two of these engines were retained until the mid 1930s, but they

Photo 5. Governor of the Hathorn Davey engine. Operates only on the high pressure cylinder. Under the governor is a collar in which a fork fits. This fork will rise when the governor does, turning the (short) shaft in front which is connected by long rods to the valve eccentrics. f3.5 1/8 second exposure on 400 ASA.

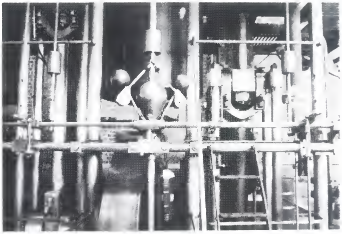


Photo 6. The governor on Austral Otis Number 8. The differences between this governor and that on the Hathorn Davey can be seen. The governor will cause an earlier cut off on first the high pressure, then the intermediate and then low pressure cylinders. The diagonal arms are fixed at the top so with centrifugal force the weights move outwards causing the centre weight to rise up the shaft. This will cause the (top) horizontal shaft to slightly rotate and through the arms at both sides of the photo to push or pull the vertical rods which are attached to the admission valve eccentrics. The crosshead (on the right) for the high pressure cylinder can also be seen with the four steel rods going down to the pump plunger. The tank behind the governor is a receiver- reheater for steam between the high and intermediate pressure cylinders. 1/8 sec on 400 ASA.

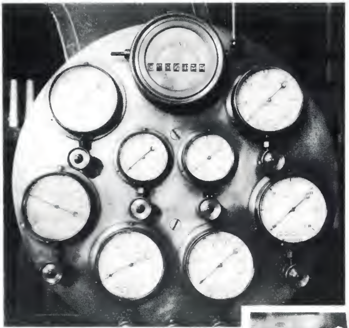
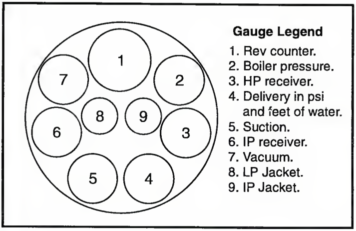


Photo 7. The gauges fitted to engine Number 8. 1/15 sec on 400 ASA.



The gauge legend for number 8 engine.

were in fact used mainly for stand-by duties after the installation of later pumping units.

More pumping engines required

In 1899, with 24,000 premises already connected to the system and additions being made at the rate of 350 per week, the Board of Works sought permission from the Victorian Government to seek tenders for two further pumping engines from leading British engineering firms. Because of strong public sentiment for the protection of local industries at this time the Government was reluctant to allow the orders to be sent to England. Finally, however, it allowed the Board to place an order with Hathorn, Davey & Co., of Leeds, for a single pumping engine with the intention that it would then be used as a pattern for further engines built in Victoria. At the same time an order was also placed with the Austral

Photo 8. The gears on the crankshaft and first shaft for driving the governor shaft (with the rag wrapped around it) and the valve shaft (not in view). This is engine Number 7 which is almost a mirror image of Number 8. 1/4 sec on 400 ASA.

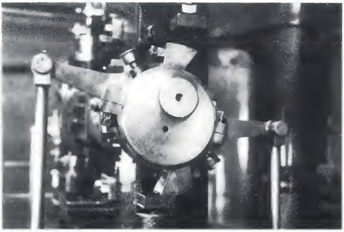


Photo 9. The admission eccentrics for the high pressure cylinder of Number 8. The bottom valve is open and will close when the cam leaves the square pad with spring assistance. The rods from the governor control can be seen. 1/8 sec on 400 ASA.

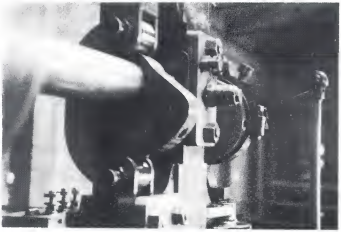


Photo 10. The exhaust valve gear for the high pressure cylinder of Number 8. In this case the top valve is open and the bottom valve is shut. As the two valves are mechanically linked, only one can open at a time. 1/15 sec on 400 ASA.

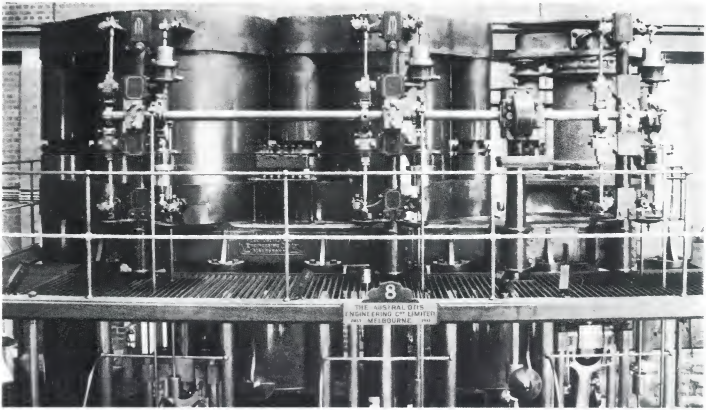


Photo 11. The Corliss valve gear and cylinders of Number 8. The asbestos lagging has been removed from all the engines. The sheathing has been removed from the high pressure cylinder of Number 8 due to condensation problems caused by running on air. The engine is run on compressed air only using the high pressure cylinder. (The valves for the intermediate and low pressure cylinders having been removed). The photo was taken using a tripod and time exposure from the platform surrounding Number 7 Pumping Engine.

Otis Engineering Co., in South Melbourne, for a second engine of similar specifications but differing design and dimensions. A number of other local engineering firms including Mephan Ferguson and Hampson & Halliday of Footscray, Johnson & Sons' Tyne Foundry, South Melbourne and C. Ebeling of Yarraville also supplied equipment for the pumping station at this time.

Hathorn Davey arrives

The Hathorn Davey engine arrived in Victoria in 1901 and was in operation by October 1902. It was, at the time, one of the most advanced pumping engines in the world, being featured in an article by the leading British engineering journal *The Engineer* shortly after its installation. In the article the engine is described as an inverted vertical 3-crank triple-expansion surface-condensing pumping engine, with steam-jacketed cylinders and inter-cylinder receivers, Porter governor and Corliss valve gear with improved

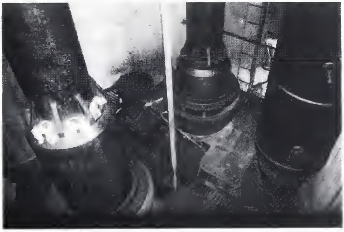


Photo 12. Looking down in the well under Number 8 pump. This area was not designed for photographers and was taken from a ladder. It shows two of the three pump plungers, each 27½" diameter, (I went and measured them) and stroke of 42". The one with the rags on it is operated by the intermediate pressure cylinder, and the one in the background the high pressure cylinder. On the right and just visible on the left are surge chambers. The rectangular castings on either side of the pump plungers are the valve covers.

Photo 13. Non return valve set. Six of these are in each well. The foot rule on top-centre gives an idea of the size. the flaps are leather with a steel plate. 1/15 sec on 400 ASA.

Craig trip motion. The clearance between piston and cylinder covers was an amazing ¼" — or less than one percent of the cylinder volume!

Comparitive testing

Shortly after, in May 1902, the Austral Otis engine was completed. Extensive duty trials were conducted between the two new engines and the original Thompson engines. The results of these tests indicated that the Hathorn Davey engine was capable of performing at 163 million foot-pounds of sewage lifted per 1,120 pounds steam consumption, 36 per cent above the duty guaranteed by its manufacturer. In comparison with the other engines this performance was 28 per cent better than the Austral Otis engine and almost 70 per cent better than the Thompson engines.

More new engines

In 1909 the Austral Otis Engineering Co. began to prepare plans for four new pumping engines — based largely on the design of the Hathorn Davey engine with a few minor modifications. The first two of these engines were installed in 1911 and the remaining two in 1914. Additional boilers were again supplied by Thompson & Co., of Castlemaine. This brought the plant at the pumping station to a total of ten manually-stoked coal-fired boilers and ten steam pumping engines, each of about 300 horsepower, with a combined pumping capacity of 80 million gallons per day (mgd).

Photo 14. Looking East at L-R the North, Centre and South rising mains of 72", 48", and 72" diameter. The riveted construction can be seen here. The small pipe between the centre and south mains is believed to be a drain line. It might also connect to the sewer of the Superintendents house. Lit by floodlights. 1/4 sec on 400 ASA.

New technology arrives

In 1918 the Board of Works invited tenders for the supply and installation of two 600 horsepower boilers and two additional steam pumping engines with a capacity of 18mgd. However, in reflection of the rapid improvements in pumping technology, a £18,572 contract was finally let, in June 1919, to G. Weymouth Pty. Ltd. of Richmond, not for steam engines but for two 18mgd single-stage centrifugal pumps and direct-coupled 440-volt 3-phase 750 horsepower electric induction motors. Both pumps and motors were installed in a horizontal position at the bottom of the only two spare wells at the southern end of the south engine-house. They were in operation by September 1921, supplied with electric power at 25Hz from the Railway Department's Newport A power station.

Meanwhile, the Board of Works also invited tenders for the supply and installation of four additional electrically-driven 12mgd centrifugal pumps to replace the four Thompson steam engines and additional by-pass sewers and hydraulically-operated 42" sluice valves to assist in better isolation of various parts of the pumping plant for maintenance. In June 1923 dismantling of the 1901 Austral Otis engine and the two 1897 Thompson steam pumping engines in the south engine-house was commenced to make way for the new electrically-driven units. Contracts were let for a third 18mgd centrifugal pump from G. Weymouth Pty. Ltd. and two 12mgd centrifugal pumps from Kelly & Lewis Pry. Ltd., of Springvale. The electric motors to drive these pumps were supplied with power at 50Hz from the State Electricity Commision's new Newport B power station.

When the installation of these pumps was completed in 1924 the Spotswood pumping station had a total capacity of 134mgd comprising five electrically-driven centrifugal pumps with a combined rating of 78mgd, and seven steam pumping engines with a combined rating of 56mgd. From 1925 onwards, all normal pumping duties were performed by the electrically-driven pumps, and the steam pumping engines being kept on stand-by to deal with storm water floods and any emergencies.

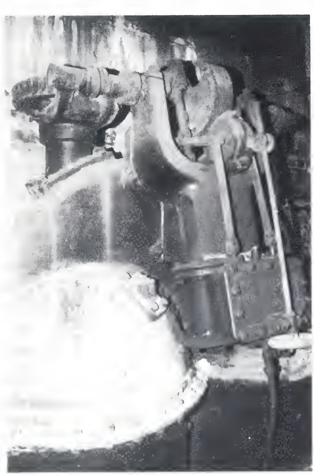


Photo 15. A close-up view of the engine and Joy valve gear on the 72" butterfly valve of the North rising main. Made by Thompson & Co. of Castlemaine. Two cylinders of 6" diameter, 6" stroke. Flash used on 400 ASA.

The demise of steam power

The two remaining Thompson steam engines were finally replaced in 1938 and 1939 with four vertical-spindle single-stage electrically-driven 10mgd centrifugal pumps. Two being installed in each of the middle wells in the north engine-house. The electric motors to drive these pumps were General Electric 400 horse-power squirrel cage induction motors with autotransformer starting control, and were supplied with 440-volt 3-phase power at 25Hz, like the 1919 motors. Unlike the earlier motors however, they were positioned at the top of the wells and direct-coupled to the cen-

Photo 16. The front of one of the two remaining boilers made by Thompson & Co of Castlemaine. There were ten of these boilers when the pumping station was using steam. The two remaining boilers were used as air receivers when the other boilers were scrapped after 1947. Note the dead weight safety valves. f3.5 1/4 sec on 400 ASA.

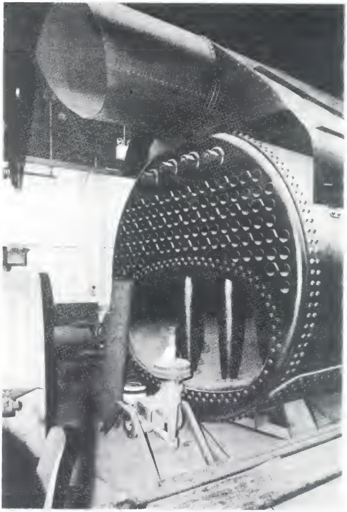


Photo 17. The back of the boiler with the brickwork removed. The combustion chamber and some of the fifteen Galloway tubes and two water pockets can be seen. There is an accumulator under the casing. The large tube is the flue exit. Flash on 400 ASA

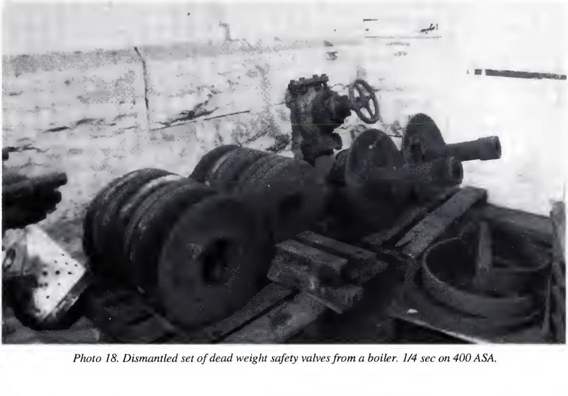


Photo 18. Dismantled set of dead weight safety valves from a boiler. 1/4 sec on 400 ASA.

trifugal pumps at the bottom with long vertical shafts. When completed, the additional pumps increased the capacity of the pumping station to a total of 150mgd, although average daily flows were still only in the order of 48 million gallons. The unit pumping cost at this time was 0.418 pence per 1,000 gallons raised 100 ft., compared with about 0.37 pence in 1903.

Steam operations continued on a stand-by basis until 1947, when the remaining four Austral Otis engines in the north engine-house and the Hathorn Davey pumping engine in the South Engine-house

were retired. Fortunately these steam engines and two of their five associated boilers were retained, as the wells which they occupied were not needed for new installations.

The end of Spotswood

In September 1965 the new sewerage pumping station at Brooklyn came on line, and the remaining electric-powered wells at Spotswood were closed down. In subsequent years the south boiler-house has been used by the Board of Works as a maintenance workshop and the coal bunkers adjoining the north boiler-house used as a pattern store. Apart from this, the pumping station plant remains as it was when last operated in 1965, with the exception of two centrifugal pumps removed by the Board for use elsewhere.

A unique site

The Spotswood Pumping Station is unique in Australia. It contains a magnificent collection of late nineteenth and early twentieth century Victorian-made engineering products with relevance to both social and industrial history. In addition, it contains the oldest surviving steam engine by the leading British firm Hathorn, Davey & Co., and ranks alongside the Kew Bridge and Kempton Park pumping stations as one of the largest intact original steam-operated pumping installations in Australia or Britain.

How the Austral Otis pumping engines work

The engine is a triple expansion condensing engine, with bores of 20" x 36" x 54" and a stroke of 42", direct acting (from the crossheads) on pump plungers of 27½" diameter. The steam cylinders are steam jacketed. Between the high pressure and intermediate, and intermediate and low pressure stages are receiver-reheaters to receive and dry the steam prior to the next stage of expansion. There is ¼" clearance between piston and end covers at dead centres.

Steam from the boilers (saturated) at 150 psi goes past the stop valve to the high pressure steam chest. The top valve opens admitting steam to start the downward stroke. At about half-stroke the eccentric cam leaves the pad and the valve closes with spring assistance. The stroke finishes using expansion (and momentum of the two 5½ ton flywheels, as well as the other cylinders). At the end of the stroke the eccentric cam for the bottom admission valve pushes down on its pad and the bottom admission valve is rotated open.

The exhaust valve for the top of the cylinder has now opened to allow the steam to flow into the receiver-reheater. the steam then goes through the intermediate pressure cylinder at about 40psi before exhausting into another receiver-reheater then entering the low pressure cylinder at 3 to 6psi. From the low pressure cylinder the steam is exhausted into the condenser. The condenser is located just above the pumps, (about 30 feet below floor level). Sewerage is the cooling medium and the air pump is operated directly from the low pres-

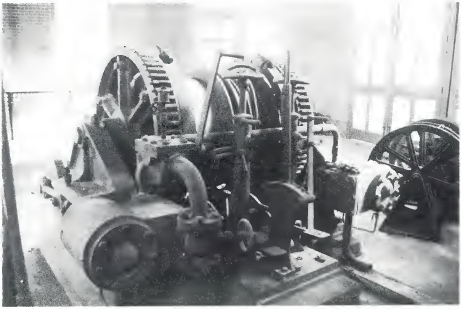


Photo 19. Winding engine in the straining well used to raise and lower the strainers. It was built by J. D'Grady (O'Grady?) of South Melbourne in c. 1897 and is a 6" x 8" twin reversing engine. The pulleys on the floor used to be attached to the roof beams. f3.5 1/15 sec on 400 ASA.

Photo 20. Strainers. Normally only one strainer would be raised at a time, the other being in the well. This pair were installed by 1930 and operated by an electric motor on left. f3.5 1/60 sec on 400 ASA.

Steam Pumping Engines at Spotswood

Engine	Description
5	Hathorn Davey. Last used circa 1922.
7	Copy (with modifications) of Hathorn Davey built by Austral Otis in 1911. Currently under restoration to run on steam.
8	Copy (with modifications) of Hathorn Davey built by Austral Otis in 1911. Almost a mirror image of number 7. Currently running on compressed air as a demonstration engine.
9 and 10	Copy (with modifications from engines 7 and 8) of Hathorn Davey built by Austral Otis in 1914. Engines 9 and 10 are almost mirror images of each other.
An Austral Otis designed engine was built over well 6 in the early 1900s. It was scrapped around 1925. Number 6 was tested against the Hathorn Davey and was found not as efficient.	

Steam Pumping Equipment Specifications

Installation date	Well numbers	Manufacturer	Horsepower	Steam pressure (psi)	No. of steam cylinders	Bores x stroke	Stokes per minute	No. of pump plungers	Pump bore	Discharge rate (mgd)
1897	3, 4, 9, 10	Thompson & Co.	about 300	150	2 x 3	16¾", 26⅛", 44⅛" x 36"	16	4	32"	8
1902	5	Hathorn Davey	296 ihp 275 bhp	150	3	20", 36" 54" x 42"	24½"	3	28½"	8
1902	6	Austral Otis	282 ihp 257 bhp	150	3	21", 37½", 57" x 36"	30	3	27½"	8
1911	7, 8	Austral Otis	293 ihp 270 bhp	150	3	20", 36", 54" x 42"	24½"	3	28"	8
1914	11, 12	Austral Otis	293 ihp 270 bhp	150	3	20", 36", 54" x 42"	24½"	3	28"	8

Electric Pumping Equipment Specifications

Installation date	Well numbers	Manufacturer of motor	Horsepower fo motor	Volts	Phases	Frequency	Revs/min	Manufacturer of centrifugal pump	Discharge rate (mgd)
1920	1, 2	G. Weymouth Pty. Ltd.	750	440	3	25Hz	480	Harland Engineering	18
1923	6	British Thompson-Houston	750	415	3	50Hz	486	Harland Engineering	18
1923	3, 4	British Thompson-Houston	500	415	3	50Hz	747	Kelly & Lewis P/L	12
1937	9, 10	General Electric Co.	2 x 400	440	3	25Hz	735	Kelly & Lewis P/L	2 x 10

South engine house contains well numbers 1 to 6
North engine house contains well numbers 7 to 12.

sure pump plunger. The condensate is dumped into the well to be pumped out with the sewerage.

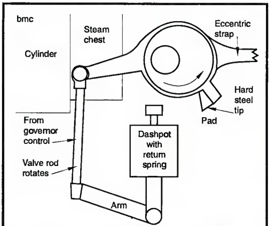
The valves and governor

As the crankshaft turns a bevel gear turns a short perpendicular shaft (photo 8) which rotates a vertical shaft (Governor shaft) at twice the speed of the crankshaft on which the Porter Governor is mounted. At the top of the engine the governor shaft rotates the horizontal valve camshaft at the same speed and direction as the crankshaft. The valve camshaft has on it three exhaust valve cams and six admission eccentrics. Each eccentric has an eccentric strap with a cam to open its respective admission valve. To stop the straps from rotating they have an arm to which is fitted a long vertical rod attached to a horizontal shaft which is slightly rotated by the rising (or falling) of the governor. The governor has a fork and collar arrangement and is fixed to the shaft at the top of the linking arms. (Photo 5 shows this best). Centrifugal force will cause the governor to move up the shaft and when this happens the vertical rods rotate their eccentric and cause an earlier cut off of steam so the engine slows fractionally.

The timing of the exhaust valves is fixed. The engines ran at about 24 revs/min.

How the valves obtain rotary motion

The cam pushes a rod up or down which in the case of the admission valves passes through a dashpot which contains a return spring. This rod moves a short arm which rotates one end of a rod, the other end of which turns the valve.



How the admission valve works

Engine viewing opportunity

Sunday to Friday Number 8 is run on compressed air for tour groups and the action of the governor can be demonstrated. Only the high pressure cylinder is used to run the engine, the valves for the intermediate and low pressure cylinders having been removed, and no pumping is carried out. Number 7 is being restored for operation on steam.

Thanks

Since requesting information on the Spotswood Pumping Station in an earlier issue of AME I have received a lot of information. My thanks to Peter Lukey, Kevin Eisfelder, Matthew Churchward and Des Lang.

Peter Lukey sent me a copy of the history of Spotswood written by Matthew Churchward, Curator of the Scienceworks at the Victoria Museum, which includes Spotswood.

Realising that we were talking about one of the top industrial archaeological sites in the country, I asked for and received permission to reprint the history of Spotswood in AME. Next I received a letter and some photos from Kevin Eisfelder who is one of the dedicated band of volunteers who look after the massive engines at Spotswood.

I replied, asking Kevin if he could take some photos of the valve gear of the engines, as the Hathorn Davey engines were unique, being vertical triple expansion engines with Corliss valve gear. Kevin did us proud, as you can see by the photos with this article plus sketches showing the operation of the valve gear and the layout of the pressure gauges.

Dave Harper

References

The Victorian Steam Heritage Register by Matthew Churchward.

Pumping Station Guide Notes by A. Miller and F. Steuart.

Also see: *Australian Model Engineering* Issue 52, Pages 9-12 and 45. Issue 63, Pages 22,23.

Club Roundup

compiled by David Proctor

West Ryde NSW

SLSLS celebrates its 50th year of operation during 1998 and members are having a busy time making plans for the parties! Work is progressing on extending the operation of the elevated track (full-size) ground frame signalling system. The concept for an anti-tip rail for the elevated track has developed to the stage where the platform area is to be fitted for evaluation. The bottom curves have received some additional ballast to improve superelevation levels. Test buffers have been fitted to some ground level tracks. The new drawgear on the elevated trucks has been supplemented by full end boards to bring them up to the same standard as the ground level ones.

The local council is undertaking major drainage works on the site, possible some time during 1998. This has involved much discussion with council and the tenderers for the job. Club members have elected to lift and replace the track themselves to ensure it is not damaged. The duration of the works and impact on club running is not certain at this stage, but will involve missing at least one running day.

The recent AGM saw Warwick Allison continue as President and Henry Spencer as Secretary.

Sydney Live Steam Locomotive Society

Location: Anthony Road, West Ryde.

Public Running: Third Saturday.

Club Roundup contributions

AME is pleased to receive club newsletters for consideration in this section. Newsletters are often a good source of articles, which we appreciate all the more, but most of all they help us keep in touch.

It is often difficult to decide what to publish and what to leave out. and the task of selecting material for a wider audience takes a lot of time. Also, there is always the risk that AME will publish something that the club considers sensitive. Please help by sending a "press release" page with your newsletter, or highlight the items you think we could use. We'll give first preference to clubs that help us out this way.

bmc

Gore NZ

The three-colour light signalling system is now up and running but the lamp and indicator have been removed from the semaphore signal to prevent further damage.

Members will be combining with the Invercargill club for the Riverton Model Show on the first weekend in November.

Gore Model Engineering Club Inc

Location: Hamilton Park, Gore.

Public Running: third Saturday.

Millswood SA

The recent Model Railway Show brought together over sixty exhibits from around South Australia, showing railways in every conceivable form. SASMEE members showed an assortment of locomotives, mostly 5" gauge, hot air engines and Bert Francis ⅔rd size Stanley steam car. The boating members showed a variety of models including a motor launch, tug, freighter, rowing boat, motor launch and steam boat.

South Australian Society of Model & Experimental Engineers Inc

Location: Off Millswood Crescent, Millswood.

Public Running: 1st Sunday and 3rd Saturday.

Gisborne Vic

The majority of the track has now been made — there are only three sections to go. The riding carriages are to be constructed and some fencing organised. The aim is to have the first running day on the 1st Sunday in October.

The committee has decided to go ahead with the plans to construct a shed to house the steam roller and portable engine in the RCA compound. This will allow the thresher to be placed under cover for restoration.

Gisborne Vintage Machinery Society Inc

Location: Steam Park, Webb Crescent, New Gisborne.

Public Running: first Sunday.

Maryborough Qld

MELSA is the custodian of ex QGR locomotive No.299 (Walkers Ltd No.1). To mark the centenary of this historic locomotive, the Association has published a glossy covered book, *Steam Locomotive No.299 - Our Living Heritage* which covers the life of the lo-

Coming Events

1, 2 November
Wagga Wagga Invitation Run

5" and 7¼"g track in scenic surrounds. Model traction engine track, Boats on the Wollundry Lagoon. HO gauge model railway.

Contact: David Font (02) 6921 4762

7 to 9 November
RAILEX 97, Tasmania

Evandale Light Railway and Steam Society invites all interested to visit their grounds for a fun weekend of railways.

29, 30 November
SSME Anniversary Weekend

Join in the fun at Luddenham Rd. St Marys NSW. On-site camping available.

8 to 12 January 1998
International Model Engineering Expo, Tauranga NZ

Model exhibition, hobby displays, working demos, road vehicles, railways 2½", 3½", 5" and 7¼" gauges.

Registration forms now available from:

Expo 98 Secretary, 326A Devonport Road, Tauranga NZ

21-23 February 1998
6th annual birthday run — Edgeworth NSW

Members of the Lake Maquarie Live Steam Locomotive Society invite all to our annual festivities at our track off Velinda St, Edgeworth, NSW. 3½" and 5"g elevated, 5" and 7¼"g ground level.

22 March 1998
50th Birthday invitation run — West Ryde NSW

Come and celebrate 50 years of operation with the members of the SLSLS at their Anthony Rd. track site. 2½", 3½" and 5"g elevated, 5"g ground level.

10 to 13 April 1998
AALS Convention

Castledare Miniature Railway, Wilson, WA. Contact Ken on (08) 9375 1223

10 to 13 April 1998
South African National Steam Meet

Hosted by Durban Society of Model Engineers, Virginia, Republic of South Africa.

6 June 1998
D-Day, HME at Galston NSW

A **D** for **D**iesel day will be held at the Galston Valley Railway, 29 Mid-Dural Rd, Galston. Petrol or electric traction also invited. NO STEAM locos please. 3½" and 5"g only. Call (02) 9484 7583 for details.

3 to 6 September 1998
Major Centenary Exhibition

The Society of Model and Experimental Engineers (UK) 1898 - 1998. At Brunel University, Uxbridge, West London, England.

comotive in considerable detail. The intention is that any profits from the sale of the book will go towards maintaining the locomotive in running order and continuing restoration work.

The annual gathering for the Spring Festival was well attended by visitors from other clubs, although general public numbers were down. The Kuskie Award for best completed model was won by George Punter of Bundaberg for a twin glow aero engine and Bill Olds won the McWatters Award for a partly built model with his QR A-10 in 5" gauge.

Model Engineers & Live Steamers Assoc Inc

Location : Queens Park, Maryborough.

Public Running: Last Sunday.

Galston NSW

Construction work is almost completed of an enclosed ticket box — representing a two-thirds replica of a "traditional" signal box. The new box has been erected inside the main gate and replaces the existing portable make-shift structure. Work on the unloading area shelter has been completed.

A new access rail link is to be constructed from the lowest level of the unloader to near the end of the mainline shunt to enable non-steam locos to proceed directly from the unloader to the main line. The arboreal tunnel is starting to look quite impressive. Stone embankments have been completed elsewhere and the sandstone Zig-Zag style viaduct is completed.

The boiler records have achieved a milestone in that the books now contain entries of two hundred boilers. Boating activities at Fagan Park continue regularly twice a month with a steady turn out of members and boats. Some members set up and manned a display in the Model Railway Exhibition at Springwood earlier in the year.

Hornsby Model Engineers Co-op Ltd

Location : 29 Mid Dural Road, Galston.

Public Running: Second Sunday.

Canberra Act

Members have been busy getting some major jobs done before the annual Invitation Run. The most notable has been the relocation and erection of a former bicycle shed to serve as the station building. This heritage building is to be officially opened at the Invitation Run.

The AGM in August saw John Nicholson re-elected President and Jim Mitchell as Secretary. The public continue to support club activities at the Kingston Miniature Railway at a good level.

Canberra Society of Model & Experimental Engineers Inc

Location : Geijera Place, Kingston.

Public Running: Last Sunday.

Convention Progress at Castledare Miniature Railway

by Kelvin Davis

Many things are happening at the Club to ensure that the railway and grounds are at there best for the forthcoming convention. Some of the main projects underway are:

5" gauge track upgrade

The majority of this track was hastily laid in the year prior to the 1992 convention hosted by the Club. In years following that convention the maintenance and limited upgrading of this track was only done to an area known as the convention loop.

Following the 1998 convention being awarded to the Club work has changed from maintenance to server upgrading of the 5" gauge track. This has seen the replacement of 6 sets of points with new ones (the old ones sold off to prevent reuse), modification to other points, extensive track bed work and sleeper replacement, replacement of complete sections of rail to get a truer gauge and better eveness in the rail.

Complimenting the 5" track upgrade is also the replacement of the main bridge the track travels across. This is elaborated on below.

A recent 5" gauge day was hosted by the Club. Comments and criticisms of the track were called for and the few that were made have been noted to ensure rectification is before the Convention. Many locomotives ran the long circiut without problem. Some came close to doing lap times as fast as Tom Bums consistently did on his 5" gauge Sterling during the last convention held at Castledare.

In short the members of the Club that have taken part.in the 5" track upgrade are proud of what has been achieved and hope our efforts will be rewarded by there being at this Convention more 5" gauge locomotives than have been at any of the past Conventions hosted at this Club.

Stan bridge rebuild

This is the major bridge on the Club's track layout and one of the oldest. It carries the dual gauge track of 5" and 7¼" gauge tracks.

The bridge looked its age. Having initially been built from second hand materials the repair of it was not consider worthwhile. So new superstructure has been manufactured commercially, and new decking and cross supports are about to be put into place.

The pillars will not be replaced as the existing ones have over the last 25 years settled nice and firmly in the river mud. However there will be cosmetic work done to improve the appearance of them which will not be undertaken until after the convention.

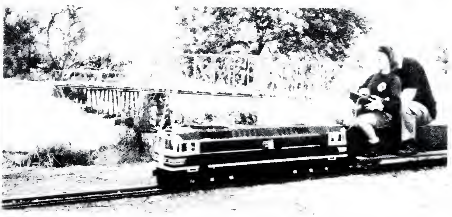
Signaling

A the work on the signaling system is on schedule to ensure that for the convention substantially all the junctions on the dual gauge i.e. 5" and 7¼" gauge track will be covered by signals. This will enhance the safety of mixed gauge operations during the convention. It will however be necessary for those attendees to the convention intending on driving a locomotive to attend briefing on the signaling system being used or to read in the pre-convention material supplied to attendees a summary of the signaling system and meaning of the relevant signals. Don't panic we will not be using the French signaling system!

Gardens and grounds

Since the last convention substantial effort and funding (including Government grants) has gone into improving the surrounding through which the railway runs. Previously barren areas now proudly support trees and shrubs up to five years old. Semi-filled wasteland areas are now cultivated grass domains.

In short not only has the track been improved since the last convention but also the grounds through which is runs. Come and see the changes.



Cliff Pole instructing his Granddaughter Katherine Brockhurst on the finer points of his 5"g 422 based on AME's construction series. The Stan bridge is in the background.

5th Annual Lake Macquarie Birthday Run

by Peter King

On the weekend of the 22nd and 23rd February 1997 the Lake Macquarie LSLS celebrated their 45th birthday by hosting their 5th annual invitation run at their track site at Edgeworth NSW The weather this year was fairly kind to us with only a bit of rain to dampen proceedings.

While some visitors arrived on Friday, the majority of visitors arrived on Saturday. While most visitors were from the Sydney area, we had quite a few visitors from the Far North Coast of NSW as well as from Orange, Wollongong, Wagga Wagga and a few interstate visitors.

While we had a variety of steam, petrol, diesel and electric locos in 5" and 7¼" gauge, we had no 3½" gauge locos visit us, which was a bit of a shame.

On display in the steam shed where a couple of stationary engines plus some part built models under construction including a 0-6-2 T cane loco in 5" gauge by Joe Huntley and a 5" gauge 4-6-2 LMS *Dutchess* loco by Frank Thompson. On the Saturday Ernie Winter, of E & J Winter Model Engineering Supplies, had a tent set up displaying and selling his products from his vast range.

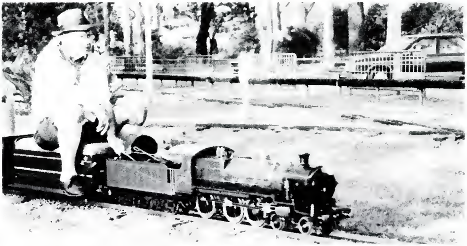
At 2.00 pm on Saturday afternoon our awards were presented for the male and the female club members of the year. These awards were presented to Jack Hicks and Daphne Little. Well done to both these people. Trains then continued running late into the evening.

Sunday was our regular public running day, being the last Sunday of the month, and were lucky in that as well as our own members, a large number of our visitors helped to haul the public. We wish to thank our visitors for their help in hauling the public.

No run would be complete without thanking the ladies of our club for the morning and afternoon teas, cakes etc. A special thanks to Ken Rowe and his hard working team who set up and cooked the BBQ and sold the sausage sandwiches.

Please make a note in your diary now for our 6th annual birthday run to be held on the 21st-22nd February 1998, which is the last full weekend in February, at our track at Velinda street, Edgeworth NSW.

A 5" gauge un-powered model of NSWGR Loco number 1 double heading with a 24 class loco from the Central Coast club at Narara.



Alan Head from the Hornsby Model Engineers driving his 5" gauge NSWGR 3501.

Lyle James driving his new 7¼"g diesel loco based on a NSWGR 47 class. The unit is powered by a 1 litre, 3 cylinder diesel tractor motor.

A 7¼"g diesel loco, with a tailshaft drive to both bogies, visiting from the Berry Railway.

Send your club news to:
AME
PO Box 176
Bundanoon, NSW, 2578

Batteries — Do, Do Not, and Maybe

by Bill Carter

Many models, and their control systems, have to use batteries of some kind or other. Depending on cost, weight, and other variables, there are advantages in using certain types for certain jobs.

This is an attempt to put a complex subject into simple terms, so the best battery may be picked for your application.

Dry cell batteries

These are cheapest for small jobs, but are thrown away when flat. I know that the commercial charges are expensive, and the chance of them restoring even 50% of original capacity is about the same as pigs in flight.

All dry cells start life at about 1.5 volts. This voltage drops fairly evenly while the battery is being discharged until the cell voltage reaches about 1 volt — at which point the cell may be considered flat. If you measured any cell at say, 1.3 volts, under normal load you could reasonably predict that this cell is about half charged.

Dry cells benefit greatly from slow discharge, say 10 hours or so. They like it even more if you can rest them for a few hours during discharge.

There are many brands, but only two basic types, the ordinary carbon-zinc, and the more expensive alkaline. The alkaline batteries last about four times as long carbon-zinc batteries.

For model use I'd limit dry cells to portable radios, torches, and maybe radio control sets, if used for about a half an hour a week or so.

Makers don't publish capacity figures for dry batteries, but I have found the pen-cell or AA size to hold at least 500 mAh, when discharged at 10 hour rate. This drops to about half that at a two hour rate. Most alkaline batteries will be four times better than this under similar conditions. I've found most Chinese made alkaline batteries to be best value per dollar.

Ni-Cad batteries

These rechargeable cells generally look like dry batteries, and are common in portable tools, video cameras, model cars, boats and planes.

One brand, Sanyo, which is not the most expensive, seems to be far ahead of all others. A visit to any club which race cars, or flies electric will confirm this.

They nearly all have their capacity printed on the label with some info on their charging rate. For instance, many AA size batteries will state capacity as 500 mAh. This means that you ought to be able to take 50mA out of the cell for 10 hours. With most brands you can do just that. With many brands you'll only get about 400 mAh if you need to get it out in two hours. One brand will give almost Nameplate Rating over a two hour discharge. Better still, it often gives nearly 75% of rating, even when bashed flat in only four minutes.

It is very important that all ni-cads be charged and discharged in sets, so they all stay balanced. Damage will always occur to any cell of a series D set which goes flat before its mates going below zero volts. This flat cell will try to charge in reverse if the load is not removed.

It is also desirable that all ni-cads be full discharged down to 1.1 volts per cell. This prevents memory effect, which lowers available power.

I used to discharge ni-cad batteries through a car tail lamp, all the while watching a volt meter, so I didn't over do it. Now I use a Dick Smith kit-built discharger (cost about $30). It suits any ni-cad battery from 3.6 volts to 12 volts.

With a discharge rate selectable to 50mA or 200mA, it switches itself off at an end-point of 1.1 volts per cell. I've fitted a $5 Asian Quartz clock to tell me exactly how much power is remaining in the battery when it is connected to the discharger.

I used to say, "any one can build this kit" — but a couple of recent repairs has changed my mind.

All ni-cads have a rating of 1.2 volts per cell. They give this voltage from about 98% full, right down to 5% full, so you can't tell the state of charge just by checking the voltage.

Ni-cads are available in many sizes and shapes — some are pre-assembled into matched sets.

The common sizes that interest us as follows:

- AA size, rated 500mAh, 600mAh, 700mAh
- C size, rated 1200mAh, 1400mAh, 1700mAh
- D size rated 1200mAh, 4000mAh
- Sub C size, rated 1200mAh, 1400mAh, 1700mAh
- Buggy Packs usually rated 7.2 volts. At 1200mAh, 1400mAh, 1700mAh

Some ni-cads, usually with an R in the code number, can be safely charged from flat to 95% full in 15 minutes. There are expensive chargers which sense this point, either by rapid cell temperature rise, or by sensing the turn-over point where the charge voltage, which rises slowly on charge, starts to fall. If sensing fails for any reason — damage, or explosion will occur.

All ni-cads love a long slow charge of around 14 to 24 hours from flat. They are not severely damaged if you forget and leave them on charge for a few hours more. You should measure the current from your charger, or better still, build your own, so you know the ideal charge time.

The life of a ni-cad battery is not impaired by rapid (15 minute) discharge, as long as you don't go below its end-point. Good brands of batteries, if used weekly, should last about five years.

Your average radio t/x takes 150mA to 190mA so will usually run about four hours on a full set of 700mAh cells.

Some idea of expected performance from a well-matched model, using a cheap 540 style motor, and 1700mAh Sanyo battery follows.

- A car will do 30 mph for four minutes, or can be geared for 20 mph, and do about 14 minutes — both on level, flat road.
- A 1:100 scale destroyer, geared down 3:1 does scale speed of 33 knots for 20 minutes.

Ni-cad advantages

- Ni-cads will provide a long service life in most brands if treated well. They have light mass for the power available, versatile shape, and will tolerate deep cycle.

Disadvantage

- Ni-cads are expensive over 1700mAh rating, and too costly over 4000mAh.
- It is not practical to measure the state of charge.

Lead acid batteries

The traditional car battery, also bike batteries, gel batteries, and the Gates starved acid battery. All of these are available in 6 volt, or 12 volt nominal rating.

Car batteries go from about 20Ah, up to over 200Ah. they contain liquid sulphuric acid, so are used in the upright position. They will stand moderate overcharge, as long as you replace the water vented off as gas due to the overcharging.

Even the so-called deep cycle examples give poor life if discharged to end-point often. They do much better if you choose a battery big enough to never go below 50% before recharge. Failure after only 10 full discharges is not uncommon.

Some car batteries last more than five years in a car, because the auto regulator quickly tops up the system — even after a slight discharge.

You can measure the state of charge with a hydrometer, or better still the state of charge can be determined with a volt meter while the battery is still on charge.

Car regulators are set at about 14 volts so you shouldn't need to add much water. The common, cheap 4 amp home charger is excellent, if you take the battery off charge when the voltage reaches 15 volts. The acid will

bubble quite freely at this point. The common charger will continue to raise the voltage to round 17 volts, and boil the battery dry.

There is a super accurate voltage regulator chip available at Dick Smith, and other electronics suppliers at round $1.75 each. The chip is the 7812 (for 12 volts) or the 7805 (for 6 volts). A pair of chips, and about $2 worth of small parts, added to a common charger will give a unit as good as any commercial auto charger of similar size — anyone can build it.

See the following article... ed

Gel batteries

These are like small car batteries, but are almost completely sealed. The acid inside is in jelly form, so the battery can be mounted in any position.

Battery ratings go from 500mAh to 20Ah or more. For most part, the ni-cad is a better bet below 6 volts, 4 amps or 12 volts, 2 amps.

I've run some gel batteries for over five years, yet others have failed in just three weeks. Worse, the warranty is often full of holes. That said, they are still the only viable alternative in the range of 4Ah to 20Ah. This includes most ship models from 1 to 2m long. All brands I've tried, have been subject to a high rate of early failure. Makers say you can only expect 30 cycles to end point, before failure. At 50% discharge, they say 100 cycles+.

Use the biggest battery you can afford, and fit in the model. They are all 20-hour rated, and the manufacturer's graph predicts less than half of the name plate rating if knocked down in one hour.

Do match the motor, gearing and prop to job. Also use good alignment, low loss bearings, and lubrication. It is possible to charge gel cells on a common charger, of appropriate voltage rating. I know one careful model maker who listens for a faint bubble sound that occurs as battery goes into overcharge. Remember you can't put back any water lost this way. Severe overcharge makes these square shaped batteries into football shaped junk.

The only safe charger is an accurate Voltage regulated type, and again, the cheap 78XX chip with about $2 worth of small parts, and half hour's work is the answer.

I put my batteries on charge after sailing. They are 95% full in six hours, but normally live on the charger all the week. Overcharge isn't possible.

Gates batteries

These have a different shape, but similar power-to-weight ratio and charge restrictions to gel batteries. They are sealed, but contain a metered quantity of acid, stored in damp fibreglass separators. Cost makes them non competitive in Australia.

Building an Auto-regulated Battery Charger

by Bill Carter

About the only safe way to charge sealed lead acid (gel cell) batteries used in model ships, and many other common items, is to ensure that the cell voltage never exceed 2.3 volts per cell.

Fortunately there is a cheap, robust, electronic device that anyone can confidently use to do this job with absolute perfection.

It is the 78 series of three-terminal regulator sold in most electronic shops for about $2.

This magic box of tricks will accept any DC voltage up to 30 at its input, and deliver a very accurate (within 2%) voltage at its output. The last two numbers of its code type represent its rated output volts so the 7805 delivers 5 volts, the 7812 delivers 12 volts etc.

Inside this little item is a temperature compensated voltage reference, and all the bits needed to provide the specified output voltage, at any current up to 1 amp (dissipation limited to 15 watts, total).

It is fully protected against current overload, using both fold back and thermal technology — even a short circuit won't worry it. It is designed to operate hot, and a heatsink is an advantage if dissipation exceeds 5 watts.

In our case, if 78XX or its heat sink is placed where you can touch it, you can tell two states of charging (hot = still charging, cool = near full).

It will fail instantly if you connect the battery with reverse polarity.

In the simple circuit described, we fool the 7805 into providing us with 6.9 volts for charging 6 volt batteries, and/or the 7812 into giving 13.8 volts for 12 volt batteries.

I also show a schematic for a current stabilized circuit. I use it to slow charge ni-cad batteries. It is somewhat an overkill, but guarantees an exact, known, charge rate. Regardless of whether there is one cell or up to eight cells in the series pack. Therefore, I know just how long to leave 'em on!

The gel batteries I use seldom exceed 8Ah rating, so are full in eight hours, but live on the charger all week.

Ni-cads always come off when I calculate them to be full.

I started this project with the cheapest brand of household 4 amp charger, about 140mm square and 70mm high. Any common 12 volt household charger would do just as well.

In my case, I mounted a 1.6mm thick aluminium plate about 140mm x 90mm — on 20mm spacers — outside the rear charger panel. The circuit board is attached to this with Araldite®.

I had plenty of room for both 6.9v and 13.8v units, as well as fixed current units calibrated for 35mA, 50mA and 120mA. There is also room for five small polarised sockets. These are at the top of the plate for easy access to the standard battery plugs I use. All batteries can charge simultaneously. You can charge gel batteries in parallel, but takes twice as long. Do not parallel ni-cads, they won't charge evenly this way.

The 78XX is not designed to run in parallel, but, if you really need 2 Amps, then they'll do the job under protest. There are other ways of increasing current output, generally at expense of accuracy, or protection.

If you put more than one unit on one plate, remember that all units need to be insulated from each other. Particularly the bolts holding down the 78XXs.

If you only need one or two units then it's okay to build it exactly as shown in the sketch. Just mount it in any convenient place on the charger — even double sided tape will do the job. I left the original leads and clips on the charger in case they were needed for a car battery top up.

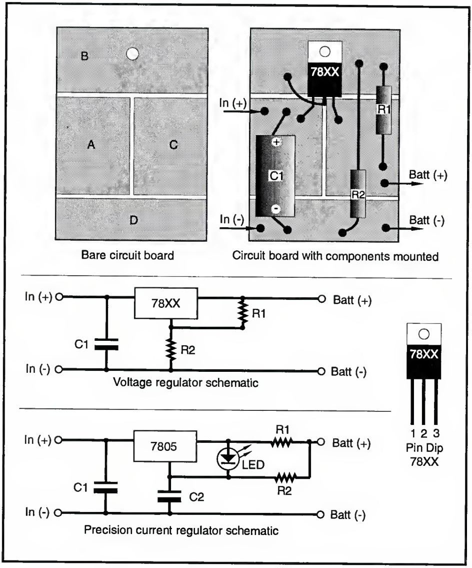
A word about common battery chargers

Common chargers show about 12 volts when measured with ordinary meters — this could never charge a 12 volt battery. The meter is reading the RMS voltage, not the instantaneous voltage. The true voltage, if no battery connected, is changing continuously at a rate of 100 times a second, from zero to about 18 volts. The battery sees the 18 volt peaks, and if it is not full, knocks them down to a steady voltage it can accept. As the battery continues to charge, its voltage would finally rise to 18 volts. At this point a car battery would be, at least, very low on water — a gel battery would be destroyed.

In the unit described, capacitor C1 (2000 mFd) sees the peaks, and provides 18 volts for the 78XX. One C1 is needed for each 1 amp unit, but the current units can use the same C1 already provided for gel chargers. The 4 amp charger will only support two gel batteries at one time.

A gel battery charger

To build one gel battery charger, the easiest way I know, is using the copper side of 1.5mm PC board. Cut a piece about 44mm x 63mm. Pencil in the three lines which will



divide board into four lands. Clamp the board, a steel rule on a marked line, onto a piece of wood, held in vice. Use a screw cutting tool or a bit of power saw blade, sharpened to 60 degrees included angle, and plenty top rake to scratch away at least 1mm of copper between each land. Check that each land really is divorced from each other land.

Next, thoroughly clean copper face, including any burrs, with steel wool. Bolt the 78XX tightly to circuit board. Be sure that no part of metal back mounting face of 78XX can touch any land except B. Land B forms part of heat sink. Bend the chip terminal 2 upward, and solder a short wire from pin 2 to land B. Solder the chip pin 1 to land A and pin 3 to land C. Cut four lengths of hook up wire, about 300mm long. Preferred colour to be, one brown, one red and two black. Solder brown to A, red to C and both blacks to D.

The brown wire will eventually connect to existing red (positive) wire from charger. I do this inside the charger, but outside is okay if you want. Likewise, either black wire goes to the charger black (negative). The remaining red and black are the positive and negative output to charge your battery. Terminate to suit with either socket or clips. Polarity is absolutely critical.

C1 is an electrolytic capacitor of about 2000 uFd. It too is polarised and must go positive to land A and negative to land D. You can get away with only one C1, to work for all regulators, so subsequent boards can be smaller. C1 is the most expensive item on the board, and should have a rating of 25 volts or more.

R1 and R2 are ½ watt, 1% resistors at about 10 cents each. Use a plastic sleeve (strip wire out of 25mm of power flex) on resistor leads spanning any land they are not connected to, R2 where it spans C.

The 6.9 volt unit is more in need of a heat sink than any other, and the biggest bit of sheet aluminium you can bolt to it (without fouling anything else) the better. If you're worried, a 5 ohm, 10 Watt resistor between land A and chip pin 1 will keep things cool.

Components

For 13.8 volt unit		
Chip	7812	
Capacitor C1	25 volt	2000 UFD
Resistor R1	560 OHM	½ watt
Resistor R2	68 OHM	½watt
For 6.9 volt unit		
Chip	7805	
Capacitor C1	25 volt	2000 UFD
Resistor R1	220 OHM	½ Watt
Resistor R2	68 OHM	½ watt
For current regulator		
Chip	7805	
Capacitor C2	25 volt	10 UFD
Resistor R1	About 50ohm for 100mA down to about 160ohm for 35mA.	carbon, 1 watt
Resistor R2	220 OHM	½ watt
LED	any 3mm LED	Remember, LEDs are also Polarised like C1

Workshop hints

Small clamps may be constructed very quickly from large Whitworth standard nuts by hacksawing a piece out of the nut a distance equal to half the diameter on either side of one corner. This leaves a stout U section, and a small setscrew is fitted, after filing up the job, providing a strong little clamp.

When filing metals it is considered good practice never to touch the surface being operated upon with the hand, as the oil which is always present thereon, tends to allow the file to slip, and is also conducive to the formation of rust.

From MEANZ — April 1937

Steam Chest

with Dave Harper

Hi there, steam fans, and welcome to another burst of vapour from the Steam Chest! Response to the last couple of issues has been gratifying, and I'd like to thank all the people that contacted me about electric drive for the Red Fred project. The most direct help came from Ray Schilling, whose Cliff and Bunting traction engine was featured in the July/August 97 issue.

Red Fred is go!

Ray has recently moved a lot nearer Brisbane than previously, and he called in to remind me of the 5" gauge model he has of Red Fred, and to tell me that he has recently converted his model from petrol to electric drive, and would I like to see it?

This was quickly arranged, and I spent a happy couple of hours looking at Ray's collection of locos, mostly electric, and the neat circle of track he has installed in his new yard. Ray told me that the electric Red Fred is very popular with his grandchildren as it is quiet and safe for them to drive, with a simple transistorised speed control operating the 12v motor.

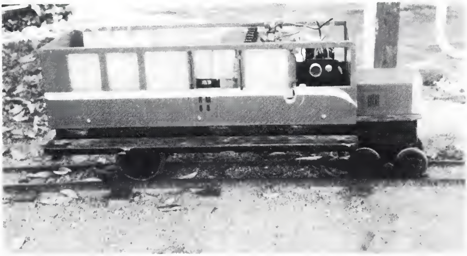


Photo 1

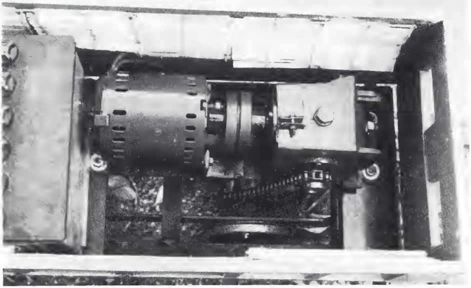


Photo 2

As it is designed to be ridden on, Ray's model is necessarily heavily built, with considerable departure from scale in the details. Photos 1 and 2 show Ray's model and the motor/gearbox drive.

As my plan is to make as near scale a model as I can, to be radio controlled so I don't have to sit on it, I have some different criteria to work to.

After considerable measuring and sketching, I realised that powering Red Fred would make it impossible to make the interior anything like scale appearance. Therefore, I decided on Plan B, to make the railmotor unpowered and to build a 4-wheeled box wagon with all the go-power in it. As these QR railmotors commonly pulled one or two trailers, this would be quite in order, and would also enable me to build any other of the numerous small QR railmotors and use the same power car to propel them.

Having made this executive decision, I drove out to the ARHS museum at Rosewood and, courtesy of the owners, photographed Red Fred from head to toe, as it were. These pictures, along with the details gleaned from old ARHS journals, should enable me to produce a reasonable model.

The speed control problem has been resolved by the timely release of a kit for controlling motors up to 12v 20A through the Silicon Chip magazine, available through Jaycar, Dick Smith and similar outlets for around $20. I have purchased a kit, but not yet built it. I'll keep you posted! Thanks to Ray for putting me onto this.

One last plea for help; does anyone have any ideas how I could produce the odd pierced disc wheels on the back of Red Fred? They are 3ft diameter, thus 4½" in 5" gauge, and are mounted on the back axle of the original AEC truck chassis. See photo 3. All suggestions will be gratefully received!

What goes around, comes around

Back in Issue No 71, March/April 97, on page 16, we published a picture of a generator powered by Tower's spherical engine. I asked if anyone knew anything about it. Amazingly, on my trip up north in June, we met Tony Little and his brothers in Chillagoe, way out towards the Gulf country, and the farthest

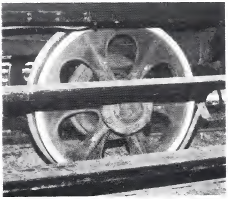


Photo 3

point of the trip. (See Travels with Kenny at the end of this column...)

In the course of conversation Tony told me that he had found a reference to Tower's spherical engine, would I like to see it? He brought out a battered volume from his set of Encyclopaedia Britannica, 1886 edition! Sure enough. in the quite long section on steam engines there was a paragraph on the engine. But no diagrams! However, Tony pressed me to take the volume home and photocopy as much of it as I wanted, then mail the book back to him.

This I did, and on reading the article through, I found that the source of the information was the Proceedings of the Institute of Mechanical Engineers, 1885. Now, thanks to my friends in the local Brisbane City Council library, and some persistence, I have a complete copy, including diagrams, extracted from the library of the University of Queensland!

Unfortunately, the article and the number of diagrams would be too much to publish in full, but I'll quote a bit from the article by Mr R. Hammersley Heenen, of Manchester:

The spherical engine consists, as its name betokens, of a system of parts within a sphere, and so united as to enable them under the action of steam pressure to impart rotary motion to a shaft. It is an engine that seems peculiarly suitable for high-speed direct driving. It is shown in Plates 11 and 12, in front elevation and plan; and is the invention of Mr Beauchamp Tower, to whom the idea of its construction originally occurred through watching the relative motions of the three parts composing a universal joint. The geometrical principles of these motions will accordingly be briefly considered first, before describing the actual mechanism by which they are practically carried out.

Geometrical construction: considered geometrically, as illustrated in Plate 18, the three elementary moving parts of which the engine is composed are - a pair of quarter spheres A and B, with a circular disc of infinitesimal thickness interposed between them, the diameter of the disc being the same as that of the sphere of which they are sectors....

Thus the description goes on for about 10 A5 pages, plus another 15 pages of discussion and 8 pages of diagrams! As I said, rather too much for most readers of AME, I suspect. However, if any readers would like a copy of the whole paper, I'm happy to oblige for my usual fee of a book of 45c stamps to cover copying and postage. Please write via the magazine.

I'm including four of the diagrams, which I hope our kind editor will find space for, as they show what a remarkable bit of engineering Mr Tower produced. According to the paper, these engines were used to power generators on locos of the Great Eastern Railway to provide lighting power for the carriages. They were mounted on top of the boiler similar to the turbine generators used on many Australian locos. The spherical en-

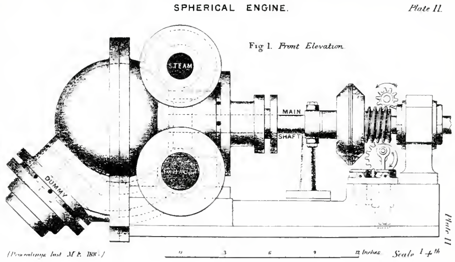


Plate 11

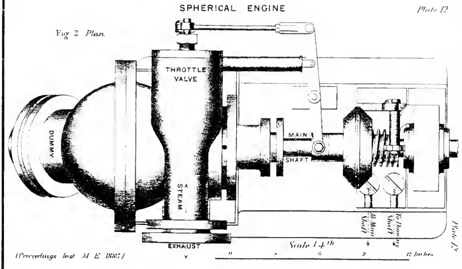


Plate 12

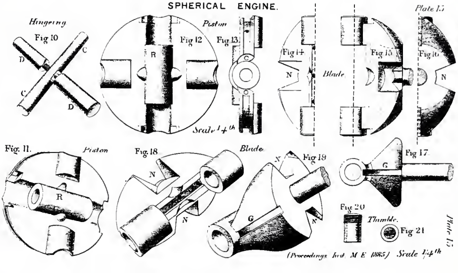


Plate 15

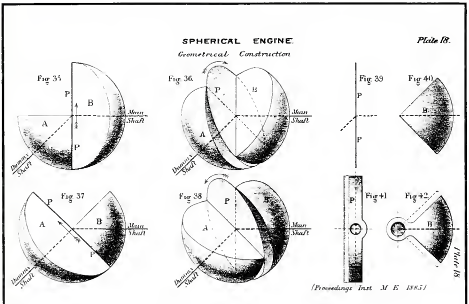


Plate 18

gines were apparently performing with excellent reliability, so I can only surmise that they were replaced by turbines which I imagine would be a lot cheaper to produce. A study of the components of the spherical engine makes it appear as a machinists nightmare!

One feature of the engine which appears to be a first, is an ingenious oil feed pump which pumps oil direct to the main shaft bearings and thence by various passages to all the working parts. This must be one of the earliest examples of forced feed lubrication - does anyone know of any before 1885?

Anyway, thanks again to Tony Little for putting me on the track of this information, and for giving us a tour of Chillagoe on his traction engine!

Are you on the beam?

For some time I have been toying with the idea of building a model beam engine for display at the Boiler House Steam & Engine Museum at Petrie. All at once, a load of information has appeared from various sources, and I thought I'd share it with you in the hope that we could start a Beam Engine Interest Group, similar to the Garrett Interest Group, to encourage people to model these fascinating engines.

Firstly, from Cornwall, England, the home of the original Newcomen pumping engines, I found that the Trevithick Society is very active in preserving the few remaining Cornish Pumping Engines. They have recently completely restored the Levant Whim, a little-known adaptation of the beam engine for winding men and materials out of the mine.

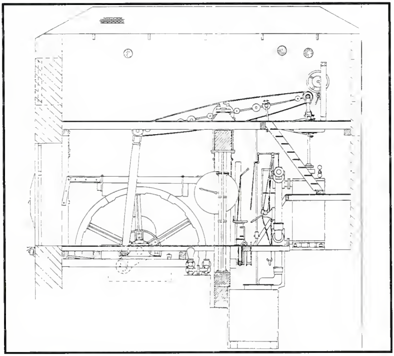
During this restoration, Courtney Rowe, the engineer in charge, who also happens to be the publication officer for the Trevithick Society, measured and drew every part of the whim, and has published the drawings through the Society Journal. It appears from my last letter from Mr Rowe, that the Society is about to publish all 60 sheets of drawings in book form, and I have written to him asking for details, which I will pass on as soon as they come to hand.

The side view of the whim was featured on the cover of their Journal, and with their permission it is reproduced here to give you an idea what it looks like.

Then, just recently, Dave Sampson showed me the latest copy of the English *Model Engineer* magazine, No. 4048, 15-18 August 97, wherein there is the beginning of a series on building a scale model of the Cornish pumping Engine at Crofton on the Kennet and Avon Canal. A full set of drawings and castings are available, and we are seriously considering building this model for our display. At least we know it should work!

Another recent visitor at Petrie was Rex Bridges from Victoria, who told me he had built a model of a pumping engine from one of the mines near Ballarat. This engine was apparently built by the local foundry there, and Rex managed to dig up enough information to build a working model which has a beam approximately 30 inches long!

So there seems to be a fair bit of interest out there in building beam engines. We'd love



Cover from the Journal of the Trevithick Society

Photo 4

to hear from any modellers in this field, and to receive pictures and details of their models!

Finally, there is an excellent book on Cornish Pumping Engines in South Australian Mines published by the Department of Mines and Energy in South Australia. The book is also available through Plough Book Sales for around $30, and is a very thorough coverage of the engines and how they work.

Travels with Kenny

As promised, here's the first instalment of engines I found on the two week trip to North Queensland I shared with Ken Saunders.

We left Brisbane early on the morning of 11th June, and headed for Gayndah, about 100kms west of Maryborough. We arrived shortly after lunch and soon met David Berthelsen, the genial curator of the Gayndah Museum.

David and his fellow volunteers have done a remarkable job in building their collection of steam engines including two small mill engines and numerous portables, one of which, a large Marshall duplex supplies steam to several other engines as well as powering a sawbench.

Photo 4 shows David Berthelsen by the big Marshall and the set of three feed pumps, all different! They are a Battle Creek, a Scotch Yoke and a Banjo pump, all operating as required.

Photo 5 is their biggest mill engine, an 1893 Walkers sugar mill engine of 14" bore x 36" stroke. Photo 6 is the 10" x 20" engine from Childers sugar juicing mill, believed to have been built by Bundaberg Foundry.

Photo 7 is a very interesting item; a Sentinel twin tandem compound engine believed to have driven a generator on HMS Australia in 1911. David doesn't have any more information than that, but would be pleased to hear from anyone who does! I'll happily pass on anything you send us....

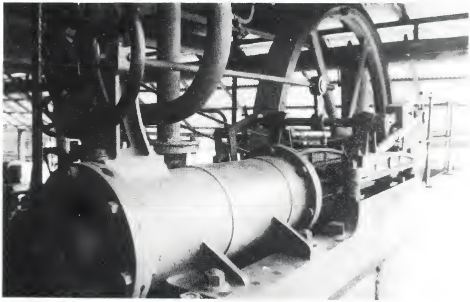


Photo 5

Photo 8 is the ex-Brisbane Main Roads Dept. Robey portable, one of several of these enclosed-crank engines at Gayndah.

There are many more things to see in the Gayndah Museum, and I'd recommend a visit to anyone travelling north.

From Gayndah we drove on to Eidsvold where I spent a very cold and uncomfortable night, but that's another story! More next time...

That's definitely enough for this time around, happy steaming!

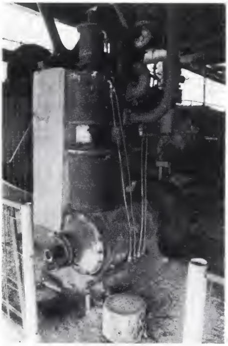


Photo 7

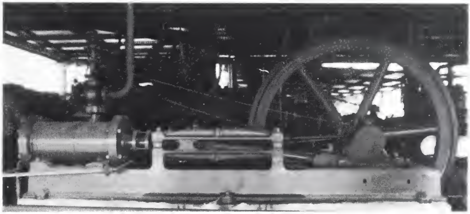


Photo 6

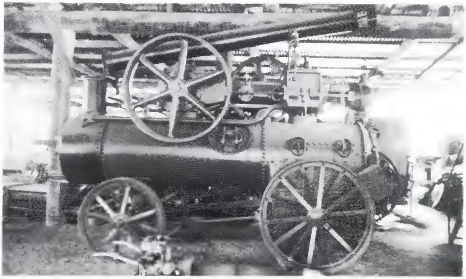


Photo 8

Locomotive Cylinder Repairs on the NSWGR

by Dick Butcher

During my years with the old NSW Government Railways, either in the running sheds, or in the city workshops, or laboratories, was a voyage of discovery. I attended TAFE doing studies for some 14 years, but you still learn on the job.

Locomotive steam chests and cylinders

Two main types of metals are used:

a) cast iron

b) cast steel

Being a Blacksmith and Welder, and in later years, as Assistant Welding Engineer with the Railways Testing Laboratories at Redfern, assisted me greatly in the understanding of these two metals.

Both materials were repaired by various welding techniques during the years that I served the NSW Government Railways.

In reflection — I marvel at the work we carried out, photographs shown in this article will clearly show the extent of some of the situations we faced.

Cast iron of the grey type served the original older classes of locomotives. It was found in many blast pipes, frame stays, valve chests and cylinders most were castings. Being generally simple to mould and cast, plus cheap to produce.

Photo 1. The cylinder from locomotive 5456 being repaired by oxy-acetylene welding. Note the flame-cut steel disk being used as a dummy cylinder cover to keep the broken segment in place during the repair process.

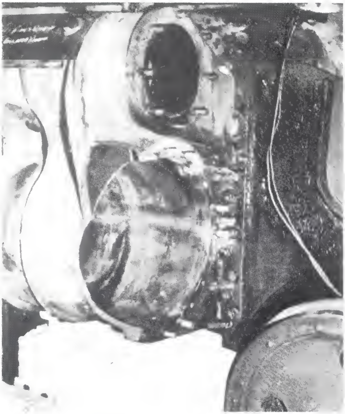


Photo 2. A C36 class cylinder failure.

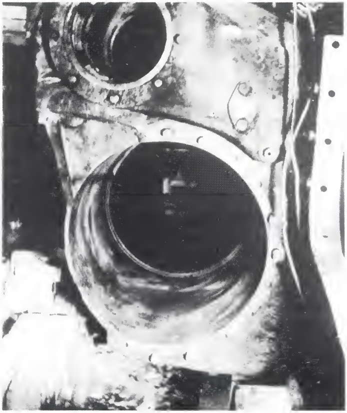


Photo 3. Another view of the C36 class cylinder failure. Note the use of firebricks to build a small furnace under the cylinder prior to welding.

One of the attributes of Cast Iron is its excellent in compression, however weak in tension. How many cheap cast iron "G" clamps have you broken when tightened?

General Analysis

Grey cast iron	
Percentages	**Elements**
3.5 to 4.5	Carbon (C)
0.6 to 0.7	Manganese (M)
1.0 to 3.0	Silicon (Si)
We always find 0.005 % Sulphur (S) and 0.005 % Phosphorous (P) as impurities.	

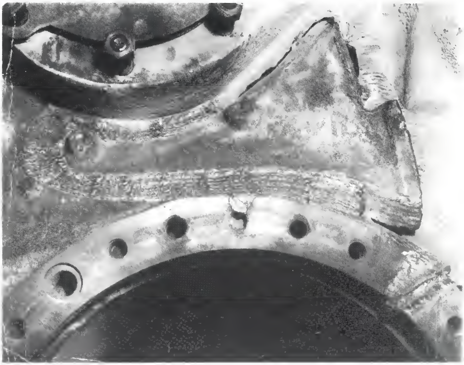


Photo 3a. A C36 cylinder block with repaired damage between the piston valve and the cylinder bore. The repair was carried out at Eveleigh using high nickel electrodes. Each batch of welds are 50mm long, the sequence and cascade technique was used.

The last two elements are always present and have to be controlled due to the fact to much Sulphur causes hot shortness, meaning brittle when hot, while excessive Phosphorous causes brittleness when metal cold.

Each element serves a purpose, for example, Silicon — its presence has a decisive role influence on the formation of graphite and softness to the metal.

Grey cast irons are the most widely used. as cheap, the proportion of Carbon governs the hardness and brittleness of the material, a greater part in the form of graphite or free carbon, being distributed in flake formation and breaks up the metals structure into cellular or spongy like structure. This breaking up of the metallic structure by graphite flakes accounts for the brittleness that is the characteristic of Grey Cast Iron. The presence of the graphite flakes also gives the metal its grey colour — grey cast iron

Photo 4. The cylinder block on locomotive 5323. The damage was repaired by bronze welding — on refelection... how did we do such big jobs?

When heated above a red heat, as in fusion welding, the free carbon combines with the metal to form iron carbide Fe3C, and if cooled too soon reverts into a hard and brittle cast iron called white cast iron

With rapid cooling, Grey cast iron changes from a grey to a white appearance in any fracture, thus white cast iron.

With the normal amount of Silicon present in grey cast iron the metal when heated and cooled slowly returns to a normal soft condition. Therefore if the Silicon is lowered greatly, for example 0.5%, the cast iron becomes extremely hard, even with slow cooling the fracture becomes whiter in appearance.

During welding, the metal is raised to a high temperature and when melted, considerable amount of Silicon may be lost from the weld melted fusion zone by oxidation: the air around the weld pool and flame influence.

- i) the brittleness of the metal which may cause the forming of fractures- when heated and cooled
- ii) The necessity for slow cooling to ensure soft metal
- iii) the necessity for a sufficiently high Silicon content filler rod to ensure a soft metal (no hard spots).

The Railway's Eveleigh foundry produced a super high silicon filler rod, found superior to trade brands of the era.

Cast Iron Varieties

There are other types of Cast Irons

- A — Malleable cast iron

Photo 5. 5367 undergoing restoration at Cowra.

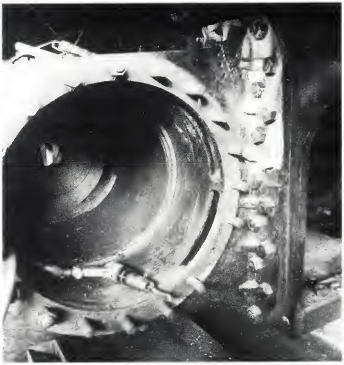


Photo 6. 5367s cylinder is in need of repair.

- B — Spheroidal cast iron
- C — Alloyed cast iron

If we increased the alloy content or alter the heat treatment of the metal a different product can result.

The best process we ever tested was the oxy-acetylene brazing process for welding cast iron, even the special creep resistant turbo chargers on the mainline diesel fleet. However, with oxy welding:

- 1. The bronze welding process
- 2. The fusion welding process

With (1) there is a different colour match but the greatest strength, we tested to destruction not only on the Railways but with 25 years of my TAFE teaching service.

With (2) you obtain the same colour match but the weld is more brittle.

Photo 7. A closer look at the damaged cylinder on 5367
A penetrant dye highlights and defines the problem cracking.

With (1) the braze welding of cast iron and malleable cast iron plus cast steel, using bronze filler rod continually tested in the TAFE end the Testing Laboratories obtained strengths greater than 450 MPa.

Manganese end Nickel-Bronze filler rod commonly used. With brazing, tinning is essential.

Tinning

The action of the flame heating the surface of the fractured metal expands the molecules and grains of metal, the molten bronze filler rod flows out end enters the grain boundaries of the metal. The surface is said to be tinned, the bond depends on molecular attraction at the junction of the weld face.

Alloying

A diffusion of the bronze into the cast iron and a corresponding diffusion of the parent metal constituents into the bronze takes place in e narrow zone.

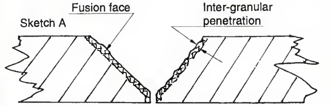
Intergranular penetration

A decided penetration of the bronze into the crystal structure of the cast iron and a corresponding infiltration into end around the grain boundaries, clearly visible under microscopic examination. See sketch A.

T T factor

An essential factor is Time temperature factor. If overheated, the weld surfaces shall be burnt, and no bonding will occur inversely if not hot enough — artificial strength is obtained, testing quickly shows the fault.

My 25 years in TAFE we taught many trades the best way to weld cast irons those



BRONZE and INTER-GRANULAR PENETRATION
(macro section 4X)

trades were:

- Blacksmithing
- Boilermakers (now called Metal Fabrication Course)
- Fitting and Machining
- Automotive Trades
- Panelbeating

Photo 8. The dye picks up furthe damage on the top portion of 5367s cylinder.

Photo 9. My assistant, Robert Bucholtz chipping a deep vee preparation prior to electric arc welding using a high nickel electrode.

Photo 10. A successful weld completed on 5367 at the Cowra locomotive depot. The drilled holes were for the mechanical brace that held the crack together prior to the more permanent repair.

The whole TAFE structure changed a few years back and it was sad to see welding hours severely reduced, to all trades, some not even taught now.

Technique

The brazing of cast iron required a special technique to successfully deposit the added filler metal. As photographs show many of the welds are carried out in the vertical up position, the bronze becomes very fluid, and gravity has nasty effects to the molten weld pool.

The molten bronze is well controlled by using a triangular pattern while progressing slowly up the incline. In fact total control achieved by placing the broken pieces in the 45 deg semi-vertical up position. And the other secret is to allow each triangular deposit to cool, then off again. Oh yes it does take years of practise to perfect the weld technique.

Testing (destructive)

The simplest and best method was to carry out a weld, then break or snap it open and look and see the strength of that weld.

With the fusion technique (same as base or parent metal) the weld broke right up the centre of the weld joint.

With bronze welding technique, much harder to snap or break open, shows superior strength, plus the weld actually breaks behind the fusion face and pulls (the deposit) metal structure away from the parent place. This proves the strength of the bronze weld See sketch B

Locomotive cylinders and valve chests

Steam buffs generally know that within the cylinders of a loco, if the cylinders cocks are not left open for a specific period of time, the loco primes and huge volumes of water globules spew from the chimney.

Imagine with a load of say 1200 tonnes, and a D57, D58, or Vic. R class combined with a cool winters day, and gallons of water accumulated within the valves end cylinders, and no where to escape. Well look at some photographs to see the resultant. Yes what a disaster, whoosh off goes the cylinder, and the poor old welder is faced with this enormous gaping hole to repair. See photos. 1, 2, 3, 3A.

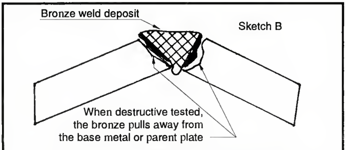
A new cylinder was most expensive, so the depot DLE would ring the Loco-Superintendent, in turn the Welding Engineer. A welding Inspector would generally go to the respective depot and line up a competent welder to effect repairs.

If say, at Eveleigh or Cardiff workshops, a break was the kind that the cylinder needed required some support to locate and hold in correct piece, a suitable mild steel ring (annulus ring) would be flame cut.

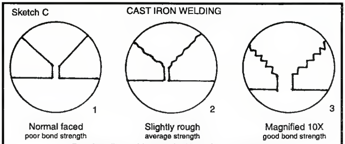
The cylinder stud holes located and drilled, the broken section bolted into position.

Weld preparation

The biggest job is the veeing of the weld faces, the base or parent metal may be up to 30 to 45 mm thick — heavy stuff!



TYPICAL CAST IRON - BRONZE DESTRUCTIVE TEST



Best bonding achieved with No. 3 for bronze welding
Reason: largest weld face area.

Employing a heavy compressed air hammer made the job a little easier for weld joint preparation. See photos 1 and 4.

Weld face

It is found that a toughened weld face is the better for maximum bond strength. Additionally with a bronze deposit filing was no good, it bought too much graphitic substance to the weld edges (face) and weakened the bond. The rougher the surface the better the weld strength. See sketch C

Pre-heating

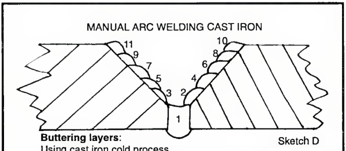
It was necessary to heat the cylinders or valve assemblies prior to bronze or cast iron fusion Oxy-acetylene welding process.

Old timber, shavings, kero soaked rags etc. being placed in the cylinders and a fire commenced. With cast iron we do not want to create sudden expansion or stress effects, otherwise more fractures can occur. The temperature achieved between 300 to 450C. Welding then commenced, and yes it could be 4 to 8 hours later till completed. Welds carried out with the bronze welding process, competent welders end faithful oxy-acetylene welds lasted from 45 to 55 years, proving the process is extremely suitable for the hard endurance encountered by the reciprocating steam locomotive in service.

The manual metal arc process

Here we can use the *hot* welding process, often used more was the *cold* process. What does this mean?

With the first, hot welding electrodes of the medium carbon range used, or the low hydrogen type. Now with arc welds the high temperature of the arc measured up to 6000 C. in laboratory tests, can revert the Grey cast iron to the harmful one white cast iron Hard and Brittle, thus failure the resultant.



Buttering layers:
Using cast iron cold process.
Beads of nickel bearing electrode line and seal the base metal.
Oil is often impregnated in the base metal.

Each job has to be measured on its own characteristic, and theta where experience counts. Small work generally satisfactory, larger work can also be successful, but the old oxy process proved A1 each time.

Cast iron cold welding

Well not really cold but total control has to be exercised, stress cracking quickly occurs.

I well remember a C36 at the large erecting shop at Eveleigh. The loco was, after 28 days in the shops on major overhaul, tested for cracks. The driver's side cylinder was found to have a 30" crack from top to bottom. No way the foreman would remove the cylinder, so it took four days of cold arc-welding with reasonable control of welding. When back in steam it leaked like a sieve. cold welding is at times an unreliable process, so after a heated debate, the Supervisor Jack Knight had the Oxy welders, Jack Pogson and Happy Johnson oxy weld the unit up in five hours — 100% successful.

Cast iron cold

The electric welder plus 55% and 100% Nickel electrodes used, sometimes monel (a Cu Ni) rich alloy employed. Weld runs no longer than 50mm are used, which means that no great heat input is allowed. In fact you must be able to place your hand on the completed weld just after you run the short bead. Patience is required, that's where the failures occur. See sketch D.

A classic example occured in 1995 when I was requested to travel to Cowra, and help the Lachlan Valley Railway weld up their loco 5367 *Rosie* off-side cylinder. See photos.

A good friend of mine who helped for 12 years on the partial restoration of the NSWRTM's 5711, Robert Bucholtz, did the weld preparation for me. The Dept. of Transport would not allow 5367 to continue to operate with a mechanical strap repair, it had to be welded.

Unfortunately most of these cylinder failures occur in the vertical or horizontal planes, thus welding has to fight the laws of gravity, that's where experience and skill counts.

I used Rocol® penetrant dyes to do the fracture tests, we then discovered that there was another crack about 7" long on the opposite side of where the initial crack was!

Robert started to chip away at the first crack and the diamond shaped chisel turned up being too soft. The chisel was quickly re-hardened and tempered and presto it was A1 again.

The metal was cast iron and ranged from 1" to 2½" thickness at the crack site was deepened out by Robert, so after 1½ days the weld preparation was completed, ready to commence the welding operation.

I decided to butter the weld faces with 100% Ni. electrodes, and use the slightly cheaper 55% Ni. rods for the fill in. Beads of 2" adhered to the metal, preventing further cracking. It's a good idea to drill a small hole in the end of the crack to prevent it from propagating (running).

While welding I lightly pein each bead to spread the soft Ni. deposit and counteract shrinkage. See cylinder photo 5, 6, 7, 8, 9 and 10

I admit the cylinder temperature was warming up a little, and one of the LVR boys was having trouble metalling some side rod brasses. We had a short break to help them.

A couple of days and the welding was finished. The repaired area was sprayed with the three basic cans of Rocol penetrant — all clear.

Conclusion

Different cast irons can be successfully welded, but care is always necessary — after all it is difficult to tell just how much stress could be in the component. The welding process is another factor, yes the skills are disappearing in time — what we used to do I marvel at today. A fellow club mate ex TAFE teacher Brian Day of HME has told me about the achievements of the now closed Cockatoo Docks, some brilliant things were carried out there, however we call it progress, I really wonder.

The NSWGR mainline diesels then entered the era, and did we carry out major welding on the fleet! Con rods do break and what big holes they left in the side of the block! We welded many of these. I was recently told that the State Rail Authority hasn't got the personnel or skills to carry out such repairs these days — it's a sad situation!

A Guide to metals for the Model Engineer

Part Two — Non Ferrous Metals, Cast and Sintered Metals

by Ken Daley

In Part 1, we discussed the selection, properties and uses of the ferrous (steel and iron) metals. In this concluding part, the non-ferrous group of metals will be discussed and we will have a brief look at cast and sintered metals.

Properties

Non ferrous metals offer the model engineer the following: good formability, attractive colour and good corrosion resistance. They also offer poor weldability and usually a strength and stiffness lower than for steels. It is generally more economic to manufacture from a non-ferrous alloy such as bronze than to use copper in a given corrosion resistant application. The coefficient of linear expansion for brass/bronze is higher than copper, which in turn is higher than steel. This can be a trap for the inexperienced model builder who has not allowed for the increased expansion of machined parts in operation.

Boiler builders note!

Please note that before using any copper or copper alloy for a boiler application, you must check that it is an approved material per the AMBSC code Part 1 (Copper Boilers). If in any doubt check with a AMBSC boiler inspector first.

Typical standards

These standards are as follows:

AS1566	Copper and Copper Alloy plate.
AS1567	Copper and Copper Alloys, Wrought Rods, Bars and sections.
AS1572	Copper and copper Alloys — seamless tube.
AS1432	Seamless copper tube for Plumbing applications.

Copper alloys

They are as follows:

Brass: Copper / Zinc

Bronze: Copper / Tin

Phosphor bronze: Copper / Tin / Phosphorus

Aluminium bronze: Copper / Aluminium

Copper Nickel alloys

The following is a guide to available grades, they are not the only grades available, but they are the ones I have found to be generally available.

Brass

- **70/30 brass or cartridge brass 260**
  (AS1566-260A) 70% Copper, 30% Zinc. Bright yellow colour, soft and ductile in the annealed state, can be severely cold-deformed by pressing, spinning or extrusion. Soldering and brazing properties are excellent.
  Also available as hard drawn brass tube (AS1572)
- **Free cutting brass (leaded)**
  Also referred to as free machining brass. (AS1567-360) 61% Copper, 3.75% Lead, remainder Zinc.
  Main uses are on Gears, pinions, electrical terminals. A better choice for riveting or bending than Grade 385.
  Soft soldering qualities — excellent; Silver soldering and brazing — good.
  Available in rounds, and sometimes hexagons and squares.
- **Engraving brass 370**
  (AS1566-370) 59.5% Copper, 1.2% Lead, 39.3%Zinc.
  As the name implies, used for engraved name plates and plaques.
  Soldering — excellent; Brazing — good
  Available only in sheet or plate form.
- **Section brass 380**
  (AS1567-380) 58.5%Copper, 2.5% Lead, remainder Zinc.
  This alloy is a bright golden colour and is used for all standard extruded shapes such as angles, flats, half round, channels and a wide range of builders hardware. Good bending characteristics, not recommended for riveting.
  Soft soldering — good; Silver Soldering — fair to good; Brazing — good
- **Free Machining brass 385**
  (AS1573-385) 58% Copper, 4.0% Lead, remainder Zinc.
  Superior machining — used for high speed repetition production machining. Wide range of shapes available, rounds, hexagons, squares, square tube. Poor riveting and bending characteristics. Definitely Not approved for boiler applications.
  Soft soldering — excellent; Silver Soldering and Brazing — good.
- **Naval brass 464 (Tobin bronze)**
  (AS1567-464 62% Copper, 1.2% Lead, remainder Zinc)
  Excellent corrosion resistance (small additions of tin), combined with good mechanical strength. Fair-good riveting and bending properties.
  Used for shafts and spindles. Rounds, some hexagons and squares available.
  Soft soldering — good to excellent; Silver Soldering and Brazing — good.

Bronze

- **Coinage bronze**
  95% Copper, 4% tin and 1% Zinc.
  As the name suggests this was used for Australia's now defunct copper coins.
- **Gunmetal**
  88% Copper, 10% Tin and 2% Zinc.
  Typical used for bearings, steam and water fittings.
- **Phosphor bronze**
  (AS122-510) 94.97% Copper, 5% Tin, 0.03% Phosphorus.
  Used for hard drawn wire, bronze wire, Bearings and wear resistant guide strips.
- **Continuous cast bronze bar LG2**
  Approximate composition: 85% Copper, 5% Tin, 5% Zinc, 5% Lead.
  This material is continuous cast to the requirements of British Standard BS1400 - LG2 it is available in round and hollow bar, and in some cases solid rectangular, solid hexagon and hollow hexagon sections. The nominal sizes include a machining allowance of 1.5mm on inside and outside diameters.

Copper - Nickel Alloys

Nickel is known for its corrosion resistance, good electrical conductivity and high heat transfer properties. Drilling of nickel and monel alloys will require you to reduce your cutting speed (ft/min) to about 1/2 of that which you would use on mild steel.

- **Nickel Silver or German Silver**
  (AS1566-757) 64% Copper, 12% Nickel, 24% Zinc.
  Extremely malleable and ductile used where extreme resistance to salt water corrosion is required. Often used for terminal and spring applications, name plates, fascias and decorative ornaments.
- **Monel**
  70% nickel, 30% copper, with small amounts of iron and manganese.
  High strength and corrosion resistance with a silvery-white lustre, used extensively in chemical and food manufacturing plants for valves, turbine blades, bolts and screws. Very tough on HSS cutting tools.
- **ETP copper 110** - Electrolytic tough pitch
  (AS1566-110) 99.9% Copper, 0.02% Phosphorus.
  Basic grade, very ductile, excellent electrical and thermal conductivity. Chips from machining are long and stringy.
  It is not suitable for Oxy-Acetylene welding, excellent soldering, good brazing.
  Available in round, square, hexagon, flats and sheet.
- **Phosphorus Deoxidised copper 122**
  (AS1566-122 sheet or AS2738 Tube) 99.9% Copper, 0.02% Phosphorus.
  The most widely used grade for welded or

brazed assemblies such as tender tanks. Soldering and Brazing -excellent.

Aluminium Alloys

Aluminium comes in a wide variety of grades, again each grade has an area of application. The aluminium industry uses a four digit index system for the designation of its wrought aluminium alloys.

- **1xxx Series**
  In this group, the minimum aluminium content is 99% and there is no major alloying element.
  The second digit indicates modifications to impurity limits. If the second digit is zero, there is no special control on individual impurities. Digits 1 through 9, indicate control of one or more individual impurities.
  The last two digits indicate specific aluminium content. Although the absolute minimum aluminium content in this group is 99% the minimum for certain grades is higher than 99%, and the last two digits represent the hundredths of a per cent over 99.
  Thus 1030 would indicate 99.30% minimum aluminium, without special control on individual impurities. The designation 1130,1230, 1330 etc indicate the same purity with special control on one or more impurities.
- **2xxx through 9xxx Series**
  The major alloying elements are indicated by the first digit, as follows:
  2xxx Copper
  3xxx Manganese
  4xxx Silicon
  5xxx Magnesium
  6xxx Magnesium and Silicon
  7xxx Zinc
  8xxx Other elements
  9xxx Unused series
  The second digit indicates alloy modifications. If the second digit is zero, it indicates the original alloy; digits 1 through 9, indicate alloy modifications. The last two digits have no special significance, serving only to identify the different alloys in the group.
- **Basic temper designation**
  In addition to the grade specification there is a basic temper designation which consists of a letter followed by a numeric subdivision:
  F — As fabricated
  O — Annealed
  H — Strain Hardened
  W — Solution Heat Treated
  T — Thermally treated - to produce a stable temper
- **Subdivisions of H Temper**
  H1 Strain hardened only.
  H2 Strain hardened, then partially annealed.
  H3 Strain hardened, then stabilised.

The degree of strain hardening is indicated by a second digit following one of the above designations:

2 — quarter-hard
4 — half-hard
6 — three quarters-hard
8 — full-hard
9 — extra-hard

- **Subdivisions of T Temper**
  T1 Cooled from an elevated temperature shaping process and naturally aged.
  T2 Annealed.
  T3 Solution heat treated and cold worked.
  T4 Solution heat treated and naturally aged.
  T5 Cooled from an elevated temperature shaping process and artificially aged.
  T6 Solution heat treated and artificially aged.
  T7 Solution heat treated and stabilised.
  T8 Solution heat treated, cold worked and artificially aged.
  T9 Solution heat treated artificially aged, and cold worked.
  T10 Cooled from an elevated temperature shaping process, artificially aged and cold worked.
  Additional digits are used to designate stress relieving.
  T51 Stress relieving by stretching.
  T52 Stress relieving by compressing.
  T511 designates minor straightening to comply with standard tolerances.

Examples

Aluminium unlike steel is manufactured in different tempers for a given grade.
Sheets are often available in "O" condition (annealed) or T3 (heat treated). T3511 is a typical temper applied to extrusions. For example, solution heat treated (softened) drawn through an extrusion die (cold worked and stretched) and then straightened.
Generally there are two series of grades available, they are the 2000 and 6000 series. The 6000 series alloys are the common alloys used for extrusions (usually 6061) and 2000 series used for sheet. Occasionally 7000 series (high strength aircraft grades) are available as offcuts or seconds. *Do not* attempt to weld 7000 series alloys into a structure, the welds will fail in service. The 1000 through 3000 series tend to be soft and gummy to machine, while the 4000 through 7000 series tend to be more abrasive and tough.

Code typical application

1100	Chemical equipment name plates cooking utensils
2011	Atomiser and hose parts, tube fittings
2017	Tube fittings, pulleys, crochet and knitting needles
2024	Aircraft parts, truck parts, veterinary and orthopaedic braces
3003	Ductwork, cooking utensils, garage doors, drawn and spun parts
4000	Heat resistance and wear applications. Forged pistons
5005	Small boats — similar usages as 3003
5052	Small boats, bus and truck bodies instrument cabinets.
5083	Welded structure (high strength) pressure vessels, storage tanks.
5086	Shipyard plate structural and marine applications.
6061	Hardware, sailboats, scaffolding, wire products, furniture, truck bodies.
6063	Irrigation pipe, windows, architectural trim, stair rails.
6262	Screw machine products, products, couplings, camera parts, nuts.
7075	High strength aircraft parts, competition car, motorcycle and bike racing.

Cast Aluminium Alloys

A system of four digit numerical designations is used for castings and ingots.

The last digit, which is to the right of the decimal point, indicates the product form:

xxx.0 indicates casting, and xxx.1 indicates ingot. In practice only the three digits before the decimal point are generally used.

1xx.x	Aluminium 99.00 % minimum
2xx.x	Copper
3xx.x	Silicon, with added Copper and/or Manganese
4xx.x	Silicon
5xx.x	Magnesium
7xx.x	Zinc
8xx.x	Tin
9xx.x	Other Elements
6xx.x	Unused series

Cast irons

Any material made up primarily of iron with about 2% or more of carbon is considered to be cast iron, with most commercial alloys containing between 2% and 4% carbon. Grey cast iron (when broken, this material exhibits a grey colour) in comparison to steel, is typically weak in tension, fairly soft, brittle, strong in compression, and has excellent damping capacities, that is they readily absorb vibrations. Generally the outer skin is harder to machine than the core material.

The methods of casting these materials include sand casting, die casting, and centrifugal casting.

Centrifugal casting offer two main advantages: hollow objects such as pipes can be cast without the use of cores, and the metal can be made to flow more rapidly into moulds resulting in denser castings.

- **Grey cast iron**
  (AS1830-1986) Iron castings — grey cast iron
  This standard covers four grades which are classified by hardness, microstructure and machinability (H series), and seven grades which are specified by tensile strength (T series).
  It should be noted that tensile strengths of the T series are based upon a 30mm diameter test bar, cast for the purpose. Since the tensile strength depends on the casting cross section a smaller cross section will

H series		
Grade	Hardness HB	
	Minimum	Maximum
H-187	143	187
H-229	170	229
H-241	187	241
H-269	217	269

T series	
Grade	Tensile Strength MPa minimum
T-150	150
T-180	180
T-220	220
T-260	260
T-300	300
T-350	350
T-400	400

SG Irons						
Grade B.S.2789 1973	Grade AS 1831	Tensile Mpa	0.2% proof Mpa	Elongation % Min	Typical Brinell hardness	
					Min	Max
SNG 800/2	800-480-2	800	480	2	248	352
SNG 700/2	700-420-2	700	420	2	229	302
SNG 600/3	600-370-3	600	370	3	192	269
SNG 500/7	500-320-7	500	320	7	170	241
SNG 420/12	400-250-12	400	250	12	-	201
SNG 370/17	370-230-17	370	230	17	-	179

deliver a higher tensile figure while a larger cross section will deliver a lower value.

SG irons

Nodular or Spheroidal Graphite (SG) iron is produced by inoculating white cast iron melts with small amounts of alloys such as nickel-magnesium (2%). Up to 17% elongation can be present in such irons, which are used where shock-resistance is required. A popular application is for the Diamond Valley Railway's auto-couplers. This material, like most other cast materials, has a hard skin. Unlike grey cast iron which produces short chips when machined, SG irons produce long chips (like steel). These materials offer significantly higher ductility and tensile strength compared to grey cast iron. The data I have may not be the latest standards but I am sure the standards can be crossed referenced by your local foundry.

- SNG 800/2 Normalising is required to achieve the mechanical properties specified.
- SNG 700/2 Normalising will improve machinability.
- SNG 600/3 Designed to cover the bulk of castings which require relatively high strength without particular thought to high ductility or shock resistance.
- SNG 500/7 The machinability of thin section castings may be improved by a simple heat treatment.
- SNG 420/12 Also a ductile grade of SG Iron, but less stringent requirements are placed on elongation and impact values.
- SNG 370/17 The most ductile of the six grades listed.

Cast steel

For the dedicated scrounger one of the more unusual metals is concrete reinforcing bars. All reinforcing bars (AS1302-1991) are now a cast steel and hot rolled with either a deformed finish (Grade 400Y and Grade 250R) or plain finish (Grade 250S). Once again the grade number refers to the yield strength in Mpa.

Welding of these grades is not as simple as it appear as the Carbon equivalent is 0.39% for grade 400Y and 0.43% for grade 250 (this is because of the silicon, phosphorous and sulphur contents).

Steel castings are available in a wide range of grades, with similar characteristics to hot rolled steel plate and bars. In practical terms there are two general classes:

(1) Carbon steel castings: Low, Medium and High Carbon

(2) Alloy steel casting.

Low carbon steel castings are weldable similar to mild steel. Medium and High Carbon are heat treatable and require special attention when welding.

Alloy steel castings include corrosion resistant castings which are often used for the food and beverage industry.

Sintered metals

Sintered metals are those produced by the techniques of powder metallurgy. This process starts with the powdered metals, which are mixed in the required proportions, then pressed into shape in a die, followed by a sinter in a furnace.

- **Their use as lubricated bearings**
  Metals formed into shape by this process, can be made with some degree of porosity, this being an advantage for such things as 90/10 bronze bearings (90% Copper 10% Tin) which can be soaked in oil prior to assembly, The oil content is an average 22% by volume and is normally sufficient for the life of the bearing. These bearings can be used where lubrication supply is difficult or inadequate.
- **Oils for sintered bearings**
  Typically the grade of oil is a turbine quality, paraffin base oil (about SAE 20). This produces a continuous operating temperature up to 85°C with intermittent maximum operating temperature up to 95°C.

Workshop Hints

When it is desired to remove a screw which has become very tightly jammed, it may often be done by a little judicious tapping with a light hammer on the head of the screwdriver. This procedure may also be used to tighten a screw, as it settles the two threads to a perfect fit.

When a shaft becomes tight in a bush, or rust holds two members solidly together, an immersion in vinegar is almost a certain method of loosening the rust and allows the separation of the two members.

Never, under any circumstances, use a file without a handle. The tang of the file makes a nasty wound in the operator's hand, if, by chance, the file jambs, and no handle is used to give protection and solid grip.

When a new file is bought, it is wise economy to use it first of all for filing brass. This preserves the cutting edges from breaking off, owing to the greasiness of the metal, whereas. when used straight away on steel, the teeth on the file are chipped and broken, shortening the life of the tool quite appreciably.

Never throw files indiscriminately into a box or a drawer. This damages the cutting points of the teeth. Always hang them up, or pack them carefully so that. one file does not rest on another.

From MEANZ — February 1937

Tracks 'n' Trees

For the Garden Railway Enthusiast

Exeter Railway Station
by John Pearce

Photos by Noel Simonds

Over the past three years I have been building a garden railway in my backyard for Gauge 1 and 0 Gauge live steam and battery. powered trains. The track, which includes a thirty five foot trestle bridge incorporating a five foot long truss over a pond, winds its way around trees, shrubs and ferns.

But something was missing. A railway station was needed to complete the railway. This is when I started to look around for ideas for an old country weatherboard station.

Living in the Southern Highlands of NSW, every now and then I would pass by Exeter Railway Station. One day, while driving past this very old English style weatherboard station, I decided this would be the one to suit my railway. From that day on, I sought to gather information about Exeter so as to build a true replica model of the station as it stands today. I was faced with trying to obtain measurements and details of the building. But one day, during our local Model Railway Exhibition, a friend of mine found a set of plans of Exeter drawn by Mark Hollands who hoped that someone would like to build it for their HO layout. You can imagine the surprise Mark received when he saw my finished model in a much larger scale.

Now I had a set of plans, I was all set to start building, but I still needed other measurements and details regarding station signs, notice boards, verandah supports, station seats, water tank, waste bins, plant boxes and many other small details so as to create a true copy in scale form I think over the seven months it took to build, I must have visited Exeter Station about fifteen times, taking photographs at all angles and gathering more information. At this point, I must thank John Wood, signalman at Exeter for the past eighteen years. He made me most welcome in his home away from home and passed onto me historical information about the beginnings of Exeter Station.

Back in 1878, the station was known as Badgery's Siding, but was changed to Exeter on August 12, 1890. The name Exeter comes from a large town in Devon, England and means *Roman station on the Exe*. There is a heritage preservation order on the buildings of Exeter Station and it still has an operating signal box that is attended twenty four hours a day. The box has a fully working lever frame to control signals and is one of the last of its type in Australia.

I have built the model to a scale of 16mm to 1 foot or 1:19. Building to this scale, my station, when completed, measured 1480mm long and 400mm to the top of the signal box which makes for a very imposing model. Being a carpenter and joiner for the past 35 years and having my own power table saw, made building this model a lot easier but it still required hours of patience, approximately 300 hours over 7 months.

The main building and signal box is made out of different thicknesses of ply. Each weatherboard was ripped to 8mm wide to represent a 6" board, sanded, cut to length then glued in place to a plywood sub structure. Starting at the bottom, working upwards, each board would lap one over the next. The windows were made by cutting up 3mm ply to various widths to make sashes and glued in place while the wall section lay flat on the bench. Later, a piece of thin glass was glued in place behind the window.

The roof is made of thin brass sheet pressed in a metal die to produce exact scale corrugated iron. Thanks must go to Arthur Gee who kindly made the die for me. The verandah supports are made of 3mm square brass, formed to the correct shape and then soldered together. Lights under the verandah and signal box light were made by cutting the top off toothpaste tubes which creates a lamp shade very close to the real lamps used at Exeter. Inside the signal box I have detailed it including a signalman operating signal levers while his workmate reads the local paper at a desk. Also, there is a cupboard, clock, notice board, heater, telephones, block instruments and a bench with books for recording passing traffic details.

A general view of the 16mm scale model of Exeter station.

A closer view showing the fine detail from the southern end.

The station platform was made from 9mm thick fibre board, covered with fish tank gravel to simulate crushed limestone. This is only used for indoor display purposes but when the station is placed outside on my garden railway running days, it sits on a concrete platform.

The painting of the station took a great deal of time as I wanted all the colours to match the existing colour scheme that Exeter is painted in today.

To further enhance the look of the station, I added people to the platform and various kinds of birds sitting on the roof. I want to thank Miss Lee Arkapaw of Bowral for making these for me which adds so much more to the station.

The many hours I spent building this model gave me a great deal of satisfaction and achievement as this was my first attempt at scratch building in scale form. The station will take pride of place on my garden railway during running days.

I am now looking forward to my next project whatever that may be. If you have never tried building a scale model, may I encourage you to do so. You just might surprise yourself and enjoy what you have achieved.

Getting The Levels Right

by Jack MacMicking

Using a piece of tube and water to obtain the levels when setting out the height of track for your garden empire is a well known technique. However, I would like to add my variation on the method for those who may be interested.

First drive in a series of posts to mark out the line of the railway, usually along the centreline, or on one side of the proposed width of the track base board if you have a good idea of the finished track plan. By placing posts at the side you can build the base board without losing sight of the level marks.

I used a 12mm diameter clear plastic tube given to me some time back which was some 3.6m long and attached the ends to two 500mm pieces of scrap 75mm x 25mm timber with suitable pipe saddles I had available. One of the timbers was fixed to a Datum point with the top of the tube some 150mm above the datum level and the other piece of 75mm x 25mm attached beside it while water was poured into the tube until the level reached the Datum line. Remember to lay the tube out in a circular pattern first to ensure there are no kinks in the tube.

With the water now level in both ends of the tube and in line with the Datum, mark a heavy black line on both pieces of the 75mm x 25mm timber at this level, it is then possible to move one end of the water tube along to each post marking them as required. Should the line of posts extend further than the length of the tube, then fix one of the 75mm x 25mm boards to the last marked post and carry on. By having the water line marked on both boards, as you move from post to post, you are able to watch the water level and make sure none is spilt from the tube accidentally, resulting in incorrect heights. As remarked in the previous article, adding a colour to the water makes it easier to see the water level and lessens the risk of error.

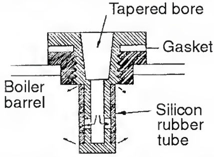
Goodall and Enots Valves

by Michael Ragg

Reading articles in the various garden rail magazines, I often came across the terms Goodall valve and Enots valve in relation to boiler fittings on live steamers. The writers always seemed to assume that their readers knew what these things were so didn't bother elaborating. Well I didn't know, but now I do so I though I'd give a bit of a description of them. Both the Goodall and Enots valves are one-way valves for filling the engine's boiler either when it is cold or in steam.

The Goodall valve

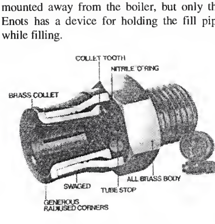
This valve is identical in principal to the older style of bicycle tyre valve which used a piece of rubber tube stretched over a thin hollow spindle, plugged one end and with a drilling through the stem as shown in the diagram.



To fill the boiler, a syringe or a plastic tube from a hand pump is pushed into the tapered bore of the valve and the water is pumped into the boiler, expanding the rubber sheath as it passes under it.

The Enots valve

Here the water filling point is usually separate from the boiler. The valve has its own internal check valve (non return valve) and a system for gripping the plastic water supply pipe similar to the gripping jaws of a clutch pencil. To fill the boiler, the supply pipe is pushed into the Enots valve where it is held securely and sealed by an O ring inside the valve. To remove the pipe, the release collar is depressed and the fill pipe is withdrawn. Both the Enots and Goodall valves may be mounted away from the boiler, but only the Enots has a device for holding the fill pipe while filling.



Gardening Tips

by Gary Warton

For that forest look, try Red Star (*Chamaecyparis thyoides*) a slow growing dwarf conifer with soft blue-green foliage in spring and summer that turns reddish-purple during winter. If you want something that you can practice your topiary skills on try Box Honeysuckle (*Lonicera nitida*) or (*Ionicera nitida aurea*) for a yellowish foliage. This can be shaped into hedges or scale size trees. For a ground cover I am trialing *Scleranthus uniflorus*, native moss-like plant that forms cushion type mats of tight foliage up to 500mm diameter. I am hoping that it will be hardier than the *Sagina* that I don't seem to have much success with.

Rails in the Garden

by Brian Carter

Jack MacMicking, Michael Ragg and Gary Warton's articles are by courtesy of the *Rails in the Garden* newsletter.

Gary Warton has been producing the newsletter for the Rails in the Garden group since Autumn 1995. Unfortunately his recent studies have put the newsletter on a temporary hold until a replacement editor can be found.

However, the group continues to operate their portable 32mm and 45mm gauge layout at special functions. Their most recent outing for the layout was at the Campbelltown Steam Museum open weekend. The group has no official hierarchy but still enjoy each other's company at exhibitions and private operating days. If you wish to find out more about this group you can write to: Gary Warton. 135 Mulhollands Rd. Picton, NSW, 2571.

I joined the Rails in the Garden group about a year ago in an effort to continue live steam in a more managable size in between my larger scale modelling. I was impressed with the relaxed gatherings and the fine looking models. All I had to do was to decide which gauge to use — 32mm or 45mm. I had begun an O.B.Bolton live steam C36 in O gauge when I was first bitten by the live steam bug about 30 years ago. My 5"g modelling is now based on a US 2ft gauge line so I decided to continue the trend in the garden — 16mm to the foot on 32mm gauge track. If I ever finish the C36 I can use the same track! A few months ago I decided to take the plunge and purchase a *Philadelphia* 0-4-2 live steam loco kit from Argyle Locomotive Works (03) 5968 6573 (kit also available in 45mm gauge).

I was pleasantly suprised at the extent of the kit. It just involves a little drilling and tapping and a bit of cleaning up. Gordon reckons it's about 50 hours work to assemble the kit! The loco frames and timber cab are all laser cut to precision. All the boiler components are cut and drilled ready for assembly. A bit of machining is required on the driving wheels and some other components. I'm looking forward to seeing it run. My thanks to Gordon Watson of Argyle for a great kit.

Freight Rail — 42206

an update by Bill Abbott

Since completing my 422 class locomotive (AME issue 68, September-October 1996, page 31) I have also completed a few more modifications which have enhanced the locomotive from an operational perspective. I would like to describe these changes to readers as they may be of interest for other diesel-outline electric drive locomotives.

End view of Bill's loco, showing the location of the D type 25 pin socket.

The controller

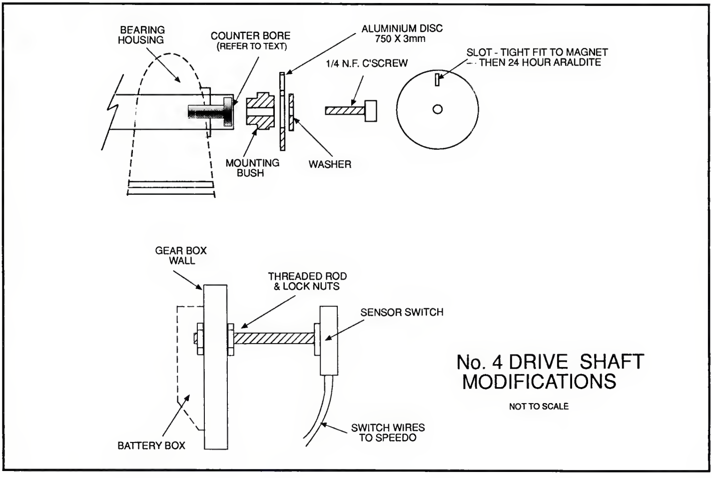
The major modification is the replacement of the original basic controller with one which has more features and functions. The new controller box is 200 x 200 x 70mm and is secured by angled frame on the front of the driving truck. The new controller is fabricated from 3mm thick black plastic sheet glued together with *Loctite 406*. The front panel is removeable for access to the birdsnest of wires.

The Dead Man's Handle (DMH) now has a reset facility which does the following: When the DMH is released the power is cut off from the motors. To restore power, the throttle must be notched back to Zero (0) before power-up is enabled. This is a very worthwhile addition as it protects the power driver transistors against power surges. AME drawing number AMLOCO13 details the modifications.

Both motors are now monitored for current drawn. An extra ammeter has been added for No. 2 motor, being wired similarly as that for No. 1 motor.

All the panel meters have had 3mm pilot globes (*Dick Smith* Catagory Number P8130) fitted, and are switched on the controller.

I find the sound system annoying at times, so a further on/off switch was added to the control panel.



This photograph shows the 25 core cable connecting the loco number one end to the driving truck

Speedometer

The speedo fitted is a Sigma Sport BC500. These are available at most bicycle shops, the functions available being time, speed, trip distance, and total distance travelled. The last function accumulates for the life of the batteries (approximately 3 to 4 years). The remaining functions are resettable to zero. The fitting of the speedo is not a major operation, but it does require the removal of the No.4 drive shaft for modification. This shaft (the No. 3 drive shaft can also be used) runs at the same speed as the bogie axles and is thus utilised as there is more room here than between the bogieframes.

After removing the shaft, counterbore the end opposite the 21 tooth sprocket to 10mm diameter x 3mm deep. Then further drill and tap for ¼"UNF x 12mm deep. This is for the attachment of an aluminium disc 75mm diameter x 3.0mm thick. Fitted to this disc is the magnet for the pick-up sensor. The pick-up sensor is attached to a screwed rod coming in from the side of the gearbox. This allows for the running gap between the sensor and magnet to be adjusted somewher between 3 to 5mm. The securing of the threaded rod is hidden by the battery box on the outside of the frame.

Extra wiring

These modifications naturally require extra wiring between the controller and the loco. This has been achieved by using 25-core computer cable. The necessary 25 pin D connector plugs and sockets are available from Dick Smith (catalog numbers P2690 and P2691), Jaycar and other electronic supply stores. I have elected to plug-in rather than hard wire the cable at the controller end. The MU receptacle openings at both ends are now redundant. A 25-pin socket is attached at No.1 loco end on the LH side of the apron plate, up as high as possible to the cab floor, so as to allow the plugging in of the new controller cable. The same arrangement is at No.2 end with a 15-pin socket, to allow normal MU operation only from this end.

Thats all

Thats about all for now. The only other modification I would like to do is to is to have dynamic braking. This I will do when I find easy to read/follow information on the subject.

As an aside, I have found the 422 class loco tracks very well, it has traversed many sets of points so far in its life and it has taken them all in its stride.

The controller for mounting on the driving truck. Note the 25 pin D connector on the base.

The Sampson Shuttle Valve for Small Pumps

by Dave Harper, Dave Sampson and Ken Saunders

Ever since Dave Sampson showed up at the Boiler House Steam and Engine Museum with his tiny model Weir pump that works, we have been trying to produce an article for AME which would share Dave's ingenious valve design with a wider audience.

Chris Wilson drew up some preliminary drawings for the Weir pump using his CAD/CAM system, but unfortunately he has since taken on other commitments which have prevented him being more involved.

Ken Saunders saw these drawings and immediately saw the potential of the idea for use on model Westinghouse pumps which are commonly used as boiler feed pumps on model steam locos. At the time Ken was struggling to get some of these pumps to work satisfactorily.

Ken has now made several sets of the shuttle valve and they are working perfectly on various locos hereabouts. However, as with all new ideas, there always seems a better way to do the job next time! The original design has several steam ports drilled through the valve casing and cylinder block, and it has been Ken's desire to simplify the tricky operation of drilling these ports that has seen him work through various prototypes. And he's still not satisfied that he's come up with the best arrangement yet!

So, rather than keep delaying the publication of the idea, I decided to produce this article which, hopefully, will explain the principle of operation of the shuttle valve, and let the rest of you loose to work out your own solutions!

The shuttle valve is one of those ideas that is much easier to convey by demonstration than through words, but I'll do my best! Photo 1 shows the parts in exploded form. Photo 2 shows the cylinder block and valve face. The dotted lines drawn on the valve face indicate the steam port's directions.

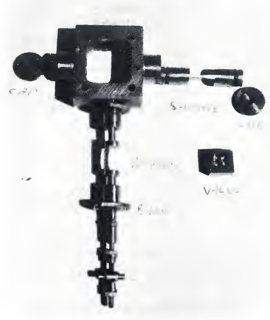


Photo 1

Description of Parts

1. Valve face; this has five steam ports arranged like a cross around the centre port. The centre port is exhaust, working on the outside steam/inside exhaust system. In other words, the steam chest is full of steam at boiler pressure and the exhaust steam is directed by the valve. This means that the valve is held onto its seating by steam pressure as with most common D-valves.

2. The valve is a sguare block with a square aperture machined into its face side as can be seen in photo 3. The size of the valve and its aperture are made so that the valve covers three of the steam ports at any time whilst leaving the other two exposed to the steam in the steam chest.

3. The steam chest is where everything happens! The shuttle fits into its cylinders across the steam chest and the valve pushrod fits up and down across it. Both these parts are cut away as can be seen in photo 1, and the valve is a neat sliding fit under both of them.

4. The shuttle consists of a double ended piston cut away in the middle to clear both the valve and its pushrod. The valve is driven left-to-right and back by the shuttle.

5. The pushrod moves the valve up and down, and is driven by levers on the Weir pump, or direct by the steam piston in the Westinghouse pump. In either case, the pushrod, and thus the valve, are only moved at the very end of the piston stroke, up or down.

6. The caps for the shuttle valve and the steam chest cover are passive parts just to keep the steam in....

Operation of the Valve

Refer to figures 1 - 4; these show the valve face with the steam ports, the dotted lines show the effective route of the steam passages and the square represents the aperture under the valve.

In figure 1 the valve is shown as it is after the piston has reached the top of its stroke. The pushrod has just moved the valve up to the position shown; the moment the valve moves up, the bottom steam port is uncovered and steam is admitted to the left side of the shuttle.

The shuttle is pushed across to the right taking the valve to the position shown in figure 2. At this point, steam is admitted to the top of the piston via the left steam port, and the bottom of the piston and the right end of the shuttle are opened to the exhaust.

The piston now moves down, its speed generally controlled by the outlet of the water pump being more or less opened.

When the piston reaches the bottom end of its stroke the pushrod and valve are moved down into the position shown in figure 3. This opens the steam port to the right end of the shuttle which moves left and positions the valve as in figure 4.

This starts the piston on its up stroke and the operation continues.

It will be seen that the valve moves in a square path, and that the operation depends on the proportions of the valve, its aperture, and the spacing of the steam ports being right to operate satisfactorily. Both Dave and Ken

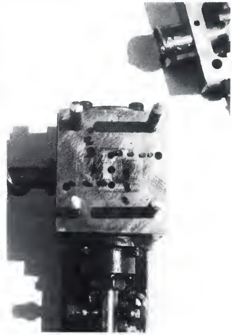


Photo 2

Photo 3

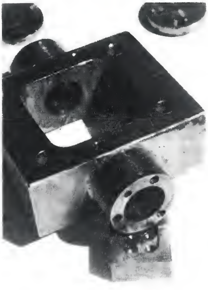
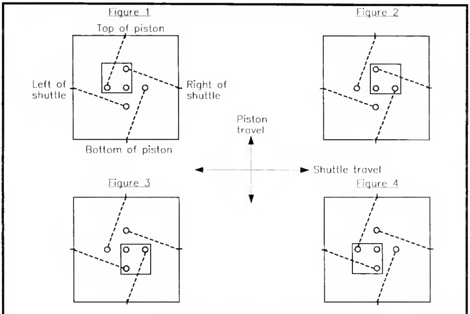


Photo 4



Sampson shuttle valve figs. 1 – 4

have made the point to me that the fitting up of the valve and other parts to match is more important than making them to any exact sizes. This is why Chris had so much trouble measuring up Dave's original model as nothing was to specific dimensions! I foresee the same problem with Ken's final model!

A couple of other traps that Ken has told me of: the pump steam piston must be steam tight otherwise the steam leaks past when it is running slowly. Secondly, the valve pushrod must be gripped gently by its sealing bush, as on one model the valve was falling by gravity before the piston reached the bottom of its stroke causing strange symptoms which took him a day or two to diagnose!

The other photos show in photo 4, the steam chest showing the tricky steam ports, photo 5 the valve in positon on the face plus the shuttle and pushrod still fitted into the steam chest, note the space where the valve fits.

Photo 6 shows the pushrod from the Weir pump made in three pieces for ease of manufacture and assembly, and photo 7 shows the bottom connection with its locknut backed off. Making the connecting thread a few mils longer gives room for fine adjustment.

Well, that's all there is to it! We hope that other model engineers will try the system out and let us know, via the editor, how they get on. I'm grateful to Dave Sampson for freely sharing his idea, and to Ken for picking it up and running with it, and to both of them for putting up with me photographing it and answering my silly questions!

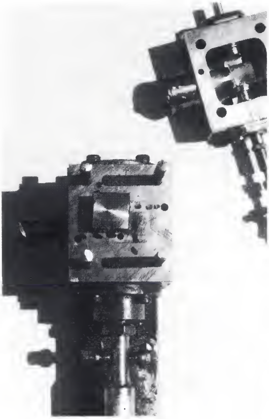


Photo 5

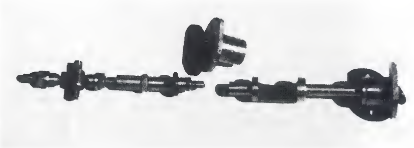


Photo 6

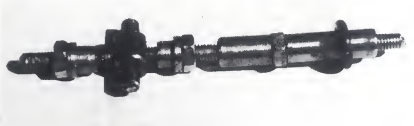


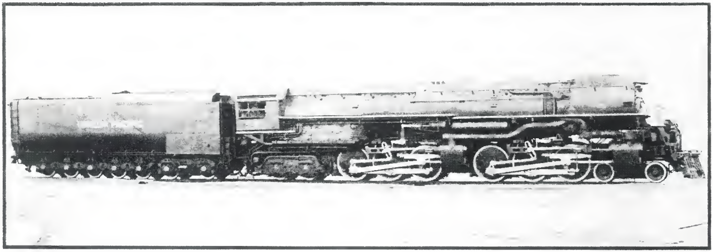
Photo 7

What a Challanger!

The beginnings of a 7¼" gauge Union Pacific freight locomotive

by Chris Hollands

Photos by Author



I started building the Union Pacific *Challenger* 4-6-6-4 because I have always done things on a larger scale and I suppose this loco fits that scenario. I prefer the looks of the more modern steam locos built in the 40s and 50s and the *Challenger* and *Big Boy* were probably amongst the most advanced and successful of latter day steam locomotives ever built.

There were 106 *Challenger* locomotives built from 1936 to 1943 and only two survive. One still runs regularly as a public relations tool for Union Pacific in the Central and Western United States. The one I'm building is the later style built between 1941 and 1943 with centipede tender; the earlier ones had smaller, more conventional tenders and were not as modern looking.

Why me?

Now I will give you a bit of my background. I am Australian and, like a lot of young Aussies, put on a backpack and traveled the world. That was eight years ago; I am now 32 and have seen and done a lot in that time — from designing and building ships in Turkey to designing and building automated robotics and component machines here in London, Ontario, Canada. I am now living in Canada for the time being, but have always called Australia my home and by the time you read this I will be back. Canada is a great place, but it's too cold for me!

It's going to be hard not having a workshop to go to for a while. My wife will be happy, as at present my workshop is in the basement and the noise from the machines seems to amplify through the house. I am looking forward to having a shed out back again. No complaints then — I hope.

What to build

Enough of the short life story. Starting to look for a loco to build, I first wanted to have a go at the last and biggest Shay geared loco built. So I went down to Cass, West Virginia, where they were rebuilding a survivor, getting it ready for the tourist season. Cass is an old logging and saw mill town that closed in 1960 and then became a State Park. I took photos, measured parts and got a lot of the original drawings from various sources.

But I ran into problems getting some of the more vital information, so decided not to continue on that project — but if anybody wants to have a go at this Shay, I have a lot of information on the loco. Maybe the Shay will be my next project in life.

I had also looked into another locomotive, a Union Pacific FEF-3 (4-8-4) with centipede tender. I was looking for information on this loco and somehow my name got on the Internet; one thing lead to another and I started talking to a Roger Goldman in California about the Union Pacific 4-6-6-4 with centipede tender. From these discussions I decided to have a go at the *Challenger* as this would certainly be something different and it is unlikely no one else in Australia would have one.

Another reason that influenced my decision to build the *Challenger* is the fact that there are a lot of parts, information and origi-

A smorgasbord of parts for the Challenger: wheels, main axles, boiler saddle, front truck, main axleboxes, valve and crosshead supports, smokebox slide and rear truck items.

Track Gauge 4'8½"	**Driving Wheel Diameter** 69"	
Cylinders Diameter21" Stroke32"	**Firebox** Length187 1/32" Width108 3/16"	**Boiler** InsideDiameter94 11/16" Pressure280lbs.
Wheel Base Driving - both 12' 2" Engine60' 4½" Engine & Tender 121' 10 7/8"	**Weight in Working order** Leading 102,300lbs Driving 404,000lbs Trailing 121,600lbs Engine 627,900lbs Tender (Loaded)441,900lbs	EvaporatingSurfaces Tubes 527 Sq. Ft. Flues 3687 Sq. Ft. Firebox 500 Sq. Ft. Circulators 81 Sq. Ft. Total 4795 Sq. Ft.
Superheating surface 2162 Sq. Ft.	**Maximum Tractive Power** 97,350lbs	**Factor of Adhesion** 4.17
Fuel Type No. 5 Oil Capacity5,945Gallons	**Tender** Type14-Wheeled WaterCapacity 25,000 Gallons	**Tubes** 45 off 2¼" 177 off 4" Length - all 20'

Challenger prototype specifications under Union Pacific

Machining the main driver on a 10" rotary table, boring crank and main axle holes— the other holes are for balancing lead weights.

nal drawings available. For a while I did think of building an UP *Big Boy* 4-8-8-4 (as both *Challengers* and *Big Boys* are basically the same) but I thought the *Challenger* was a better-looking loco. The *Big Boy* is in my opinion a little out of proportion, and trying to machine something that is bigger than the *Challenger* might have presented some machining problems.

Roger had a lot of castings available for the major components (at a price); the ones I have are as per prototype and they look as if they would be a pattern makers nightmare. They are very detailed and of a very high standard — the coring of some of these items is amazing. I wouldn't even know where to start to make such patterns.

Just how big?

To give you an idea of the scale of the engine I am building, it is 7¼" gauge or 1½" to the foot. The engine when finished will be 15 feet 4 inches long and will weigh approximately 2,400 lbs. or just over 1 ton. I prefer metric but everything in Canada and the U.S. is imperial, so I will stay with this measurement.

Machinery and size

To build something of this size you have to have, or have access to, larger size machinery. I have a Bridgeport mill and a 12" lathe with digital displays, but have been able to use some of the bigger machines at work to do the frames, rear truck and cradle. If you can afford a digital read-out get one; it will be the best investment you ever made. By using the machines at work I could get a lot more work done without moving the parts too often, or the head on the mill. The company had just bought a CNC mill package; it's great stuff. If I had the money, I would buy one. I used it to machine the axle boxes and some of the wheels — it saved a lot of time. It's too bad they didn't have this machine when I did the frames, it would have been a breeze.

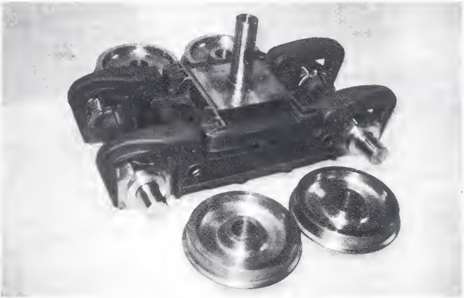
Auxiliary requirements

I want this loco to be as close to prototype as possible, with working Westinghouse Cross compound air compressors, Pyle National 12 volt steam turbine generator, Elesco feed water pump and exhaust steam injector, 4 Natham lubricators and Alco power reverse. As a result this is not a cheap loco to build, but I am sure it will be a very impressive engine when finished (hopefully) in about 6 or 7 years.

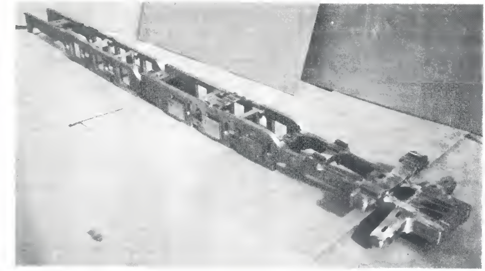
Frames and wheels

I have been working on the loco for about eleven months now and have put in just over 650 hours into it. I started with the frames which are made out of ¾" HRS x 6" wide. Being an articulated engine the rear frame and cradle is 5 foot long and the front frame is 4 foot long. Each pair of frames is bolted together and machined — this was a very involved and time-consuming job. The size and complexity of the frames meant doing what I could with the limited length of the mill table, then moving the frames and setting up for the next operation. The original frames were cast; a monumental feat which amazes me when you think about it, the pattern work alone is mind boggling. The frames took about 150 hours to make, I was glad when I got them finished.

Next, I started on the patterns for the wheels and there are a lot of them. The main drivers are of *Box-Pok* design; each set different to each other. This is another area where digital read outs are great on your mill — work out your measurements and away you go. I got about a dozen different end mills and router bits specially ground with the draft angle and radius to match the scaled wheel pattern and shrinkage allowances.



Front truck ready to be painted. The fine quality of the casting is evident.



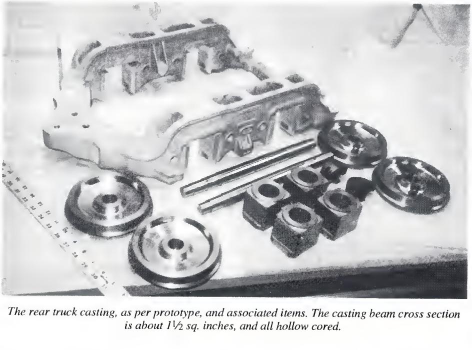
The main frames and rear cradle, with a length of nine feet. The rear frame has the axleboxes installed.

There were a few attempts at the patterns before I got them right, however they turned out very well. They are almost exact copies of the original, apart from the hollow coring. It took about 75 hours to make the three main wheel patterns and the two tender and truck wheelpatterns.

The 12 main wheels were cast and weighed 22 lbs. each; there are also 22 tender and truck wheels. I have been machining wheels for the last couple of months and as a result the main wheels are very close to being finished. As a slight deviation from prototype, the wheels will be chrome plated. I thought this was going to be expensive but to my surprise it was quite cheap (only $3 for the small and $7 for the main) and you can also select which areas you want plated. The main reason for this apart from looks is to try and stop the rust that always forms on bare metal; hopefully this will save a lot of hassle in the long run. I will paint out all except the outer rim and this should look pretty good — polished chrome with a black background.

Shafting and axleboxes

All bearings are needle roller, the main axles are 1½" diameter, all others are 1" and these are made from what is called Thomson Shafting. This shafting is for needle and linear bearings, to be able to run direct on the shaft without an inner race. This saves a lot of space in the long run in way of the axleboxes. The shafting is not that expensive and you pay by the inch. The surface 0.030" - 0.060" of skin is Rockwell 60 hardness and the rest of the shaft is normal mild steel hardness. It's best to have a couple of ceramic tips to machine this stuff as it gives carbide a hard time. I burnt the keyways in the main axles with the EDM machine at work (3⁄16 x 1") as no end mill was going to put a dent in the surface of these shafts.



The rear truck casting, as per prototype, and associated items. The casting beam cross section is about 1½ sq. inches, and all hollow cored.

The axle boxes on the prototype are one piece and the axle is enclosed in an oil bath. I want to put a triple piston ¾" bore x 1" stroke axle pump on the axles, so I had to go with the standard one axle box each side in order to be able to use the axle shaft for the eccentrics.

The trucks

This only leaves the front and rear trucks. The castings for both trucks are as per prototype; the front is pretty straightforward, except instead of spring return to center there is a rack and pinion ramp for the self centering system. The further off center the truck goes the more of an incline it encounters.

The rear truck casting is quite something. One of the members of the club I belong to owns the main foundry in London (Canada) and when he saw this and the rear cradle castings he was pretty impressed. He said they were quite the castings and looked like a lot of work went into them. The castings are all hollow cored as per prototype. I still have some work to do on the rear truck and the front truck is just about finished.

The next items are the suspension and rigging and I have the castings for the valve gear supports for the front and rear engine and then the cylinders and boiler.

I want to also start on the tender. I have 3 sheets of 16-G brass but I am waiting for the tender waterbottom casting, this casting is nearly 6 feet long by 12 inches wide. That will be some job trying to machine something of that size.

I have just found out that I may have a problem with the size of the boiler as the boiler has a capacity quite a bit larger than the 49.9 liters the Australian code allows. I have been talking with Keith Watson in Perth and he has offered advice on the requirements and the direction to go with this problem. Maybe I will have to go to commercial standards. I have invested too much time and effort (not to say money) in the locomotive to stop now!

As you can see from the accompanying photographs, this loco is a big job. Sometimes I get a little bored with certain tasks and have to switch to something else, but there is no shortage of other items to work on. I am sure that all my hard work will pay off in the end. My progress has been better than I expected but with my move back to Australia I will lose a lot of time, with buying a new house and, of course, the main priority setting up my workshop.

The future

I am looking forward to the day when I can run this engine at, say, Castledare in Perth — perhaps in six or seven years if I'm lucky, it will probably take longer but you never know.

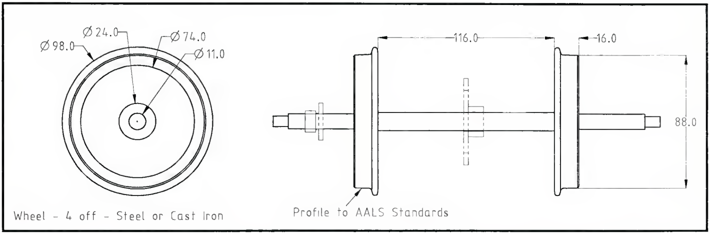
I hope to have a few progress reports as I go and if anyone is interested in finding out more about the *Challenger* or *Big Boy* castings or the Western Maryland Number 6 Shay, you are welcome to contact me (*through this magazine ... ed.*).

A Great Eastern Tram

Part 2 of a construction series of a 5" gauge battery-electric powered tramway locomotive

by John Campbell

Photos by the author, drawings for publication by Peter Manning



Wheels

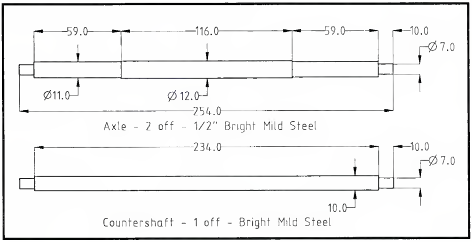
The wheels are 88mm diameter over the tread. The size is not critical but all wheels must be the same. I use parallel treads but they are otherwise to AALS standards. The radius between tread and flange is particularly important. There is no need to have spoked wheels as they are well out of sight. If castings are not available the wheels could be made from steel blanks oxy cut from plate but there would be a lot of work if your lathe is a light one like my ML7.

Wheel turning is easy if you have carbide tipped tools. Small carbide tips are not expensive and are easily silver brazed to mild steel shanks. Two tools, one a knife tool and the other with a round tip to make the radius at the root of the flange will be very valuable. For our use these tools can be sharpened on the usual bench grinder but there will be considerable wear on the stone and we will not get the best cutting edge on the tool.

Do your best to ensure that the axle holes are bored truly, finishing with a reamer if possible. If on assembly there is a slight amount of wobble it may be ignored, but if the wobble is too much for your peace of mind the wheels can be trued on their axles using the centres. Remember that the wheels must all finish at the same diameter.

Axles

The axles are made from ½" bright steel. There should be a little end play in the axle boxes so check the distance between the bearings before cutting to length. The axle ends should be a nice fit in the bearings and the wheel seats may be a press fit in the wheels. It is easier to make an easy fit for the wheels and use high strength Loctite®. If you are using Loctite place the assembly on end while it sets to minimize the possibility of running out of truth. Do not assemble the wheels until all the sprockets are in place.

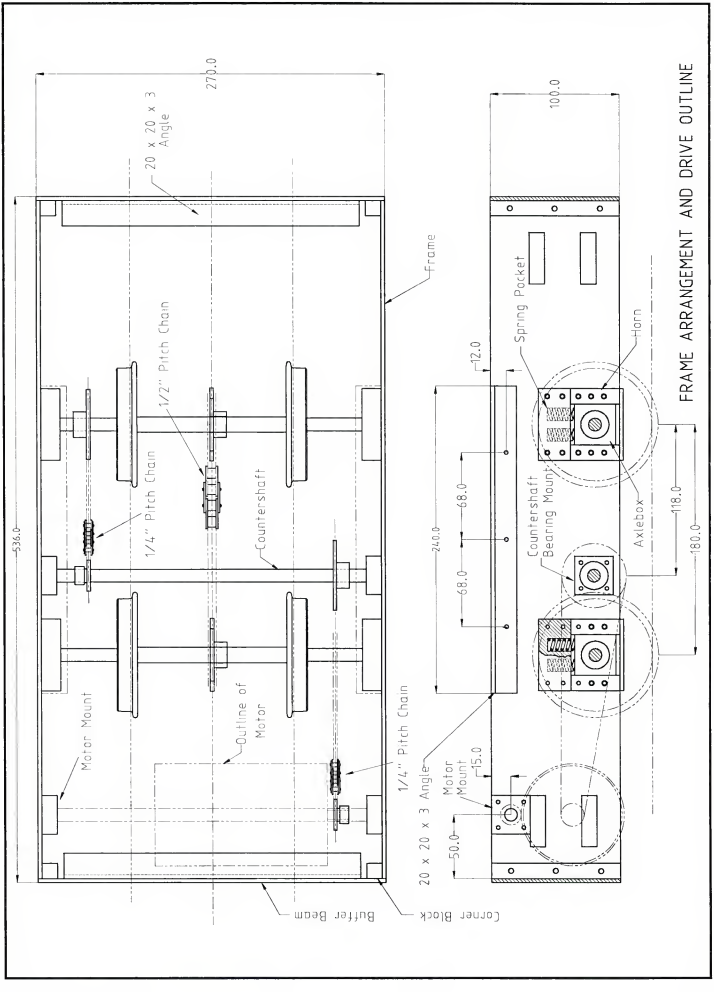


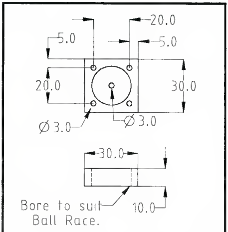
Sprockets

The axles are coupled together with bicycle chain and two 12 tooth sprockets are needed. The sprocket blanks are approximately 57mm diameter, made from 3mm sheet steel with 20mm bosses brazed in. While still held in the chuck for boring the bosses, the centres are divided and centre popped at 49mm (1.93 in.) pitch circle diameter. I have a small centre punch with a guide held in the tool post for the punching and a simple attachment which holds a change gear at the rear end of the lathe mandrel for direct dividing. The blank is drilled in the bench drill with a small pilot drill and the holes are opened up to 5⁄16". The sprocket is placed on a special mandrel and the outer diameter reduced until the holes are well opened up. A rather boring session with hacksaw and files will produce two acceptable sprockets. A trial assembly of the sprockets and chain will confirm that all is well, any tight spots needing only a little more hand work. The sprockets may be attached to the axles with Loctite and should be placed close to the wheels allowing space for the chain and joining links.

Countershaft drive

I have some ¼" pitch chain and sprockets from defunct photo-copiers and have used them for the primary and secondary drives. The final reduction is approximately 7:1 and with a 3000 revs/min motor gives a top speed of just over 7 km/h The sprockets from the copier have 24 teeth and the 9 tooth driving sprockets will have to be made to order by the builder. As these sprockets are smaller they


FRAME ARRANGEMENT AND DRIVE OUTLINE
270.0
20 x 20 x 3
Angle
Frame
1/2" Pitch Chain
1/4" Pitch Chain
Countershaft
536.0
Motor Mount
Outline of
Motor
1/4" Pitch Chain
Buffer Beam
Corner Block
100.0
Spring Pocket
Horn
12.0
68.0
68.0
240.0
Countershaft
Bearing Mount
Axlebox
118.0
180.0
20 x 20 x 3 Angle
Motor
Mount
15.0
50.0



Countershaft Bearing Mount - 2 off - 10mm Steel or Aluminium.

can be turned from steel 30mm diameter. The motor sprocket must be bored to fit the motor shaft, 7mm or whatever it may be, while the countershaft sprocket will be bored ⅜" to fit the shaft. The teeth are 2.8mm (0.110 in.) thick and the pitch circle diameter is 20.6mm (0.810 in.).

Details for making 24 tooth sprockets are included on the drawings.

When these sprockets are made you can do a trial assembly of the countershaft. Note that the primary chain must clear the front axle. The countershaft bearings can now be attached to the frames.

Motor and mount

The motor is a 12 volt permanent magnet motor which drove the circulating fan in a Commodore air conditioner. It runs at 3000 revs/min and draws a very heavy current when stalled. When you are looking for a motor look in through the holes in the end plate at the wiring. This appears to me to be about 18 gauge or about 1mm diameter.

The motor is suspended from its shaft on two straps with brazed bushes. Two smaller bushes hold a cross pin to which the torque rod is attached. When every thing is lined up the main bushes are pinned or setscrewed to the shaft and the position of the angle on the buffer beam fixed. You should now be able to roll the completed chassis along the floor or track with ease. Any tight spots should be fixed as there is no power to waste.

Trial run

If you are the same as me you will need a trial run at this stage. A temporary floor can be attached and a 12 volt battery tied on securely. Temporary leads can be attached to the motor and you can see what you have made. I am sure that you will be pleased with the result.

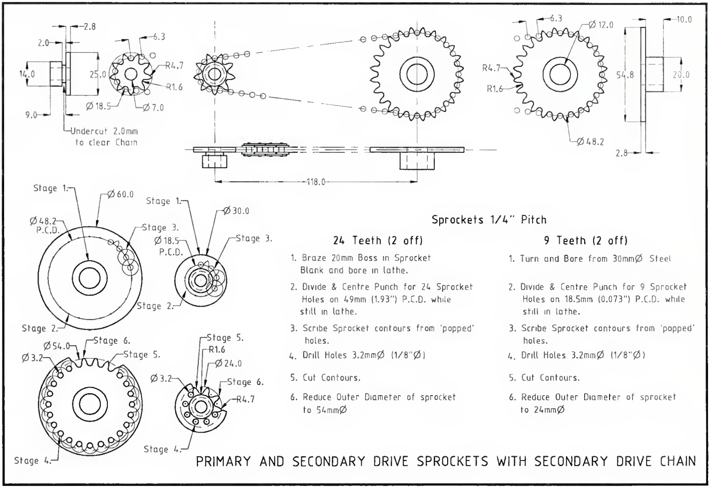
Buffers

The buffer stocks are made from steel or brass. Brass is easier to work but considerably more expensive. By now I am sure that you have found your nearest scrap metal merchant and you may have already picked up some bargains. My method of making is to rough out the shape and then machine the screwed end. The buffer stock is then mounted in a screwed bush to complete the machining.

The heads are roughed out face to face and partly parted off. Both shanks are then completed, drilled and tapped, and separated. I have made a simple copying guide for turning the curved outer faces but with only four to do it does not take very long to turn the faces freehand. I then smooth out the tool marks and round the edges by using the disc sander, of course protecting the lathe bed from the abrasive dust. The degree of polish is up to you. Spring pins and springs are simple. be sure that the springs are reasonably strong to cushion the tail end bumps that are sure to come one day.

Couplings

The front coupling is more or less to scale. The hook is made from 5mm plate. Mark out the outline and drill and countersink two holes, one for the chain and the other to start the slot for the hook. It is then time for hacksaw and files and if you are lucky an abrasive belt machine to help round off all edges. The chain is made by cold bending ⅛" rod around a simple jig of two ¼" pins in a block of steel. Actually two jigs are needed as the centre link

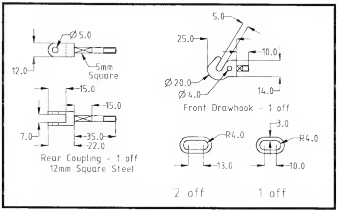


PRIMARY AND SECONDARY DRIVE SPROCKETS WITH SECONDARY DRIVE CHAIN

is shorter than the outer links. Braze the joints in the links after assembling the coupling.

The rear coupling is a more utilitarian structure being a slotted block tapped for a ¼" pin. Starting with a piece of square steel the end can be turned down to the diagonal size of the shank, just over 7mm, and then filed square to fit the buffer beam while the end is screwed 5mm. The other end is cross drilled and then slotted to easily take a ¼" coupling bar.

If you are to follow the AALS safety standards you will also need an attachment for a safety chain to hook to your driving car. This I will leave to suit your club's regulations.



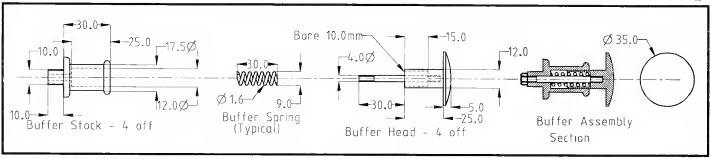
The buffer beams are painted red at the upper section and black behind the cowcatchers.

Cowcatcher

As a tram engine running on public roads it is necessary to have protective side panels over the motion work and to be fitted with cowcatchers or what the Americans call pilots. The cowcatcher may be a riveted construction of flat strip about 2mm by 6mm or may be made of 3mm round steel bars brazed to upper and lower strips of 3mm by 6mm. I had sawn strips from plate on my bandsaw for three cowcatchers and have used guillotined strip for a fourth. There is no question as to which is easier.

The top bar is straight while the lower bar has the ends bent around at 20mm radius. The catcher slopes forwards and the ends of this bar will need an extra upward twist to keep them level. Most of the vertical bars are straight but the two outer bars on each end are a little longer and will need both bending and twisting to make them fit. Two angle brackets are brazed on for attaching the catcher to the buffer beam. My cowcatchers are sprayed with silver paint. When you are mounting the cowcatchers leave about 10mm of clearance over the track.

To be continued...



Building an Astronomical Telescope

Part 5 — Conclusion — Mounting the telescope

by Doug Shaw

I offered five articles on telescope making to AME and to my surprise the Managing Editor accepted the entire proposal. I therefore do not have the temerity to suggest a sixth. On the other hand I find that I am nowhere near the end of the exercise.

I therefore crave the indulgence of the reader if I make a few quantum leaps and appeal to the good nature of those interested to study their textbook for the missing links.

In précis form then:

Primary mirror mount or bell

This needs to be adjustable in three positions around the underside of the mirror. It should impose no strain on the mirror so as to avoid distortion of the image. It must also ensure that the mirror axis remains fixed in all attitudes in which its support frame might be placed. It sometimes forms one end of the support frame.

Diagonal mirror

The diagonal mirror is front aluminized or silvered and supported centrally in the support frame of the telescope at a distance from the primary mirror such that the converging rays, on being reflected to the side of the support frame, will clear the eyepiece focussing mount and come to a focus (the prime focus) somewhere in space beyond it. The actual position must take into account the eyepieces being used. Some experimentation will be needed before finalizing the optical design.

Diagonal support

The diagonal mirror is mounted in a metal cell attached to three or four blades radiating out from the cell and fastened to the walls of the support frame. It is useful if it allows some adjustment of the diagonal mirror. Old hacksaw blades 5/8" or larger make good blades. As this support spider causes the spikes on stellar images observed through reflectors it is well to reduce their effect by off-setting the blades where they are fastened to the mirror cell so that they do not coincide with the centre line of the diagonal.

Support frame

We are all familiar with the tube as a common form of telescope but many telescopes have been made with open frameworks. A problem with any telescope is the stability or otherwise of the air column within the support frame. No doubt many model engineers will be drawn to the idea of a metal tube. Unless it is heavily insulated inside, the heat from the observer will produce tube currents which will be very destructive of image quality. Fibreglass is a good alternative and I have wondered in recent years how a piece of rigid polyvinyl chloride drain pipe would perform.

An open framework on the other hand, particularly if made of wood has had a good following over the years. I recall visiting the late Professor E.J. Harting many years ago and being shown his 30cm Newtonian, which was the instrument used to produce his monumental effort *Astronomical Objects For Southern Telescopes.* I remember his enthusiasm for his open frame telescope which he held gave the best of both worlds by enclosing both top and bottom sections only.

Something to be remembered is the lighter the tube and accessories can be made, the less onerous will be the requirements for the mounting. It would be wrong to over emphasize this but if we are to proceed with one of the most versatile types of mounting, a counterweight possibly approaching the weight of the telescope and accessories will need to be added. (If only a simple mounting is required this aspect may be eliminated.)

Finderscope

I have discussed this previously in Part 2.

Eyepieces

Nowadays eyepieces fitting a 1¼" draw tube or focussing mount seem to be the norm and my catalogues are rather depressing when looking at prices. As a start two eyepieces will have to do unless money is no object. (My suggestion nevertheless would be to purchase rather than attempt to make them.)

If one of 40x and the other of 80 to 100x were purchased much of the practical capacity of the telescope could be realized.

Magnification (M) = Focal length of Primary Mirror (f1). Focal length of Eyepiece (f2) and transposing: $f2 = \frac{f1}{M}$.

If our primary mirror f1= 1200mm, then for 40x, focal length of eyepiece:

$$f2 = \frac{1200}{40} = 30\text{mm}$$

and for 100x:

$$f2 = \frac{1200}{100} = 12\text{mm}$$

There are many types of eyepieces available as the serious reader will have already discovered and there is no room here to go into their pros and cons. Suffice to say that a good all round performer is the Orthoscopic eyepiece and although it has the common defect of internal reflections, these are faint and unobtrusive. When purchasing, ensure that each has good eye relief. That is, the image is formed well clear of the outer end so that the eye does not need to contact the eyepiece when observing.

Requirements for telescope mountings

It is necessary for telescope builders to understand how the sky "works" to be able to determine the kind of mounting needed for their own particular interests.

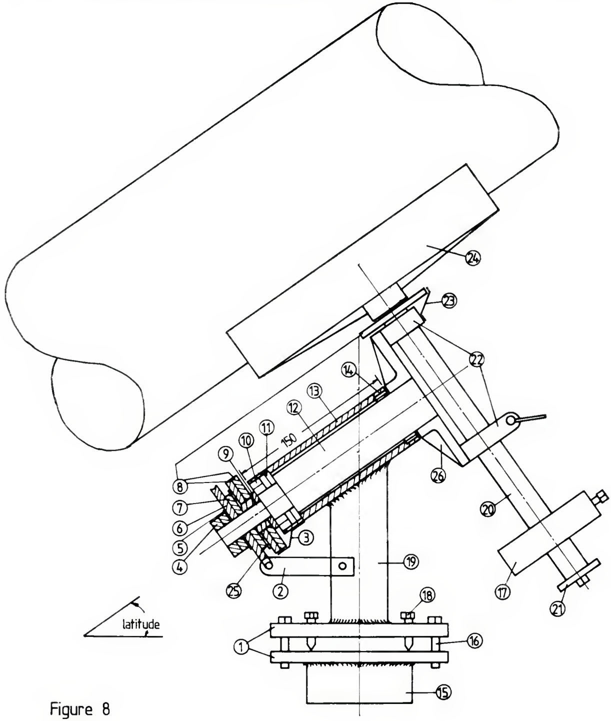
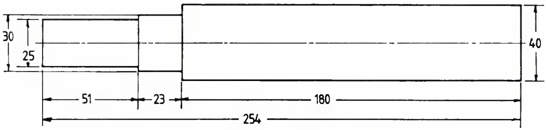
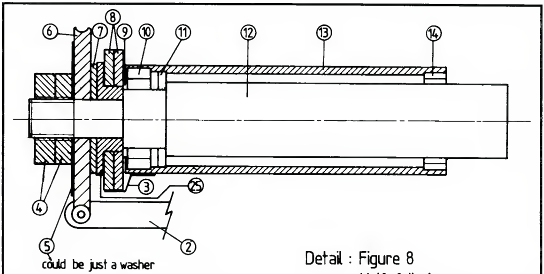


Figure 8

not to scale



Detail of Polar Shaft.



Detail : Figure 8
Half full size

object observed, that only one motion is now needed to keep it in view. What was the vertical shaft of the Alt-Azimuth has become the Polar shaft of the Equatorial mount. If the Polar shaft is fitted with a disc graduated in hours and minutes of arc and the Declination shaft with one graduated in degrees, the telescope can be used to find otherwise difficult stellar objects. Of course one must have a good sky atlas or catalogue of objects giving their description, RA and Dec.

The equatorial mounting allows a final refinement apart from the convenience of easy viewing. Long exposure astronomical photography is possible if the Polar shaft is driven backwards against the direction of the Earth's rotation and at the same rate. This means that the object is fixed in view as long as the operator desires, although some minor manual adjustments may still be required.

Having thus defined the principles of the equatorially mounted telescope, we must now see how they can be applied in practice and this means entering a rather diverse field and I must ask the serious reader to once again consult the literature. In practical terms, as with the tripod or other support a good mount must be very rigid, as previously stated. Ordinary mechanical engineering designs based on strengths of materials no longer apply. The enemy to overcome is vibration and this often means deeply ribbed cast sections for some designs and large diameter shafts for the axes in others, or a combination of both. Some designs have deep forks cast in either iron or aluminium. The last adapt well for permanent mounts in backyard observatories.

For our telescope I will propose a design known as the German mount. It can be readily detached from its support for portability and this will be combined with a permanently installed concrete pier to provide good rigidity.

First the pier: this should be made from a 1.2m length of 100mm diameter concrete drainage pipe set vertically in the ground in concrete to a depth of 450mm. Choose the best location available for viewing the night sky.

Next obtain a threaded 80mm water pipe ferrule and set this vertically in concrete in the top of the pier so that it protrudes about 25mm. This should be topped with a matching cap to ensure that the thread is not allowed to deteriorate from exposure. This arrangement will permit removal of the telescope and mount for safe storage when not in use.

Figure 8 depicts the elements in a German mount in which I have been deliberatly vague for most details to allow the builder freedom to make his own choice on how to proceed. The whole arrangement should be treated as a

Because of the daily rotation of the earth on its axis, the stars appear to rotate about a fixed point in space in each hemisphere. I'm sure most are already aware of this and have seen photographs of circular star trails to demonstrate the point, each star tracing out the arc of a circle against the night sky at its own radius about the celestial pole. Unfortunately there is no easily visible star in the Southern Hemisphere to mark the centre of rotation. In the Northern Hemisphere, the Pole star stays put for any Northern latitude and remains the same height above the horizon for that latitude all year round. Just as the globe is criss-crossed with a grid system of latitude and longitude, a celestial grid has been delineated on the sphere of the heavens with its axis of rotation passing through the North and South Celestial Poles (NCP and SCP). The great circle constructed between the celestial poles is divided into 180 degrees, commencing at the NCP at +90 degrees,through the equator at Zero degrees to -90 degrees at the SCP. The term given to this celestial latitude is Declination, either North (+) or South (-).

The celestial equivalent to longitude is Right Ascension (RA) and is measured around the celestial equator from that position of the sun when its path intersects the celestial equator in the Northern Spring (Vernal Equinox — 21 March).

A great circle drawn on the celestial sphere through this point on the celestial equator is the heavenly equivalent of the prime meridian of the terrestrial sphere. Right Ascension advances Eastwards from zero. The celestial equator is divided into 24 hours or 15 degrees per hour and each hour is further divided into minutes. Thus the positions of celestial objects can be defined. For example, the position of Sirius is RA 6hrs 42.9m, Dec -16 degrees 39 minutes of arc.

Choice of a telescope mounting

There are some simple requirements for mountings. Foremost among these is *rigidity*. By far the biggest bogey of the amateur observer is vibration. Professionals have the luxury of mounts weighing, in some cases, many tonnes. All the amateur can do is use careful design to make good viewing attainable. Some commercial tripods are totally inadequate being but wind shaken devices that often negate the value of the optics. Much can still be achieved with a well designed tripod. Regardless of the type of mount, all require the ability to provide two motions at right angles to one another. This implies bearings which must have a smooth motion, low friction and no play between shafts and bearings.

The simplest and most common mount is one arranged so that one axis is vertical and the other horizontal. The telescope tube is fitted with trunnions at its centre of gravity which fit into bearings in an enveloping fork. The base of the fork is attached to the vertical axis which allows full 360 degree rotation of the telescope in the horizontal plane. Ninety degree vertical motion is provided by appropriate design of the fork. Such a mount, known as an Alt-Azimuth, will require frequent adjustments of both axes to keep a celestial object in view and cannot be used in the present context for photography of stellar objects.

However the moon provides enough light for very short exposures and possibly now under good conditions with high speed film, some of the planets. It is not capable of finding objects using coordinates. Nevertheless it can be quite staisfactory for general observing. Provided this is the sole aim of the amateur astronomer it is simple to make. In some designs it is very robust and vibration free and generally very effective. There are good commercially available kits at reasonable prices which meet these criteria. Alternatively designs such as the Dobsonian mount, can be found in the literature.

The other general type of mount is the Equatorial. In essence this is merely the Alt-Azimuth with its vertical axis tipped over to an angle with the horizontal equal to the latitude of the observer and aligned to point at the celestial pole. One will realize with this dodge and the declination shaft clamped fast on the

guide only with the possible exception of the Polar shaft. In fact the whole layout has been designed around this item.

The following notes refer to some specific aspects.

Polar and declination shafts

Whilst the Polar shaft will produce best results with ball and needle bearings, the Declination shaft requires plain bearings only. Both shafts need a means of restraint. I have shown the Polar shaft fitted with a clutch and the Declination shaft with a clamp merely to indicate two methods of doing so. My preference however would be to provide clamps for both shafts. If this suggestion is followed, items (4), (5) and (7) are deleted together with the thread on the end of the Polar shaft. The worm wheel would require the addition of a boss 25mm long, slit across its diameter, over which a clamping block and lever would be fitted.

The same principle applies to the Declination shaft but in this instance the lower bearing block is modified as shown (22), and slit to allow the clamp to tighten on the shaft.

Worm drive

If the worm drive (2) is extended, this allows the attachment of a flexible cable and handwheel, and if required a power drive for the Polar shaft. Here the builder will be able to select from a wide range of suitable miniature AC synchronous electric motors with intergral reduction gearboxes. The choice will have to be made to suit the number of teeth to be hobbed on the worm wheel to produce the correct rate of rotation (for all practical purposes 24 hours for one revolution of the Polar shaft). A further refinement allowing slow motion corrections of the Polar shaft is available if a variable frequency A.C. supply is applied electronically to the motor.

Setting circles

The general term for the graduated discs shown on the Polar and Declination shafts is setting circles. The Declination shaft has only one, but if the Polar shaft has an additional disc scribed with a single line anywhere on its circumference and is secured to the shaft as is the Declination shaft disc, it facilitates the convenient location of objects. In this circumstance the RA disc on the Polar shaft is left to run free.

General

It is worthwhile for builders to consider making patterns for the telescope support cradle and the Declination shaft base and having aluminium castings made. Otherwise mild steel fabrications are quite satisfactory apart from the additional weight incurred.

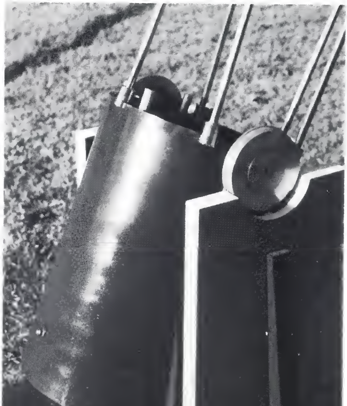
I wish all enthusiasts happy viewing.

Epilogue

Readers of this series of articles will no doubt appreciate that they were written in general terms, merely describing how to go about making a class of reflecting telescope known as a Newtonian. Now, as I am not a fluent writer, all this has taken a little time. Sufficient in fact for me to have been taken in by my own notes, to the extent that the urge to "do it all again" was too strong to resist. The result is to be seen in the accompanying photographs and, while the telescope breaks no new ground; there are some innovations which builders might like to consider.

Firstly, to combat atmospheric corrosion the instrument has been designed with non-ferrous materials and stainless steel throughout and has a tightly fitting anti-dust cover over the mirror cell. Free access for a flow of air through the mirror cell when the telescope is in use, facilitates temperature adjustment of the mirror. It is important to blacken the inside surface of the tube in some way, the aim being to eliminate stray sky light degrading the quality of the image. A visit to a fabric shop produced a black cotton twill which I found refused to reflect grazing light almost to

The upper tube.



The lower tube and mounting.

perfection, is far superior to the conventional painting job with a spray can which in similar circumstances can produce quite a sheen, and so was duly installed.

Another addition, managed without undue difficulty, was to make the three mirror aligning screws operable from the front of the mirror. This greatly facilitates collimating, since the mirror is in continuous view during the adjustment process. Builders who have experienced the tedium of the conventional method using rear adjustment will perhaps consider this alternative arrangement. It does however require the addition of a simple screwdriver-type tool and three guide tubes fixed to the inside of the tube above and covering the aligning screws of the mirror cell. These little tubes can be seen in the photographs, protruding from the top of the lower part of the telescope tube.

The mount has an azimuth ring graduated in degrees which I generated using a computer CAD program. When time permits to I will be adding an Altitude ring to one of the tube trunnions so that finding celestial objects will be a simple matter if used in conjunction with a computer planetarium program.

General Description of Telescope

Material of primary (Objective) mirror blank: Fully annealed Pyrex glass.
Thickness of primary mirror blank: 40mm.
Diameter of primary mirror blank: 215mm.
Diameter of clear aperture of primary mirror: 209mm.
f number of primary mirror: 6.3.
Focal length of primary mirror. 1370mm.
Tube framework: Stainless steel bar 10 mm diameter.
Weight of tube assembly: 22kg.
Focuser: Helical, with 32mm (1.25") inside diameter draw tube.
Finderscope: 25 mm. O G. diagonal type with illuminated graticule (WW2 gun sight!)
Secondary mirror: (Diagonal) minor diameter: 40min.
Tube: UPVC pipe. 240mm inside diameter, 5mm wall thickness.
Trunnions: Cast aluminium.
Counterweight: 9kg mild steel. 234mm diameter x 28 mm thick (hidden in lower base).
Type of mount: Dobsonian.
Material of mount: Particle board, 28 mm thick faced with Laminex (all over).
Baseboard pivot shaft: mild steel bar 16mm diameter.
Fork base bearing: 16 mm self aligning ball race.

To facilitate perfect contact between the baseboard and the fork disc (between which a very large felt washer is sandwiched), a self-aligning bearing was used for the baseboard pivot. To assist manoeuvrability, castors will be added to the baseboard when time allows.

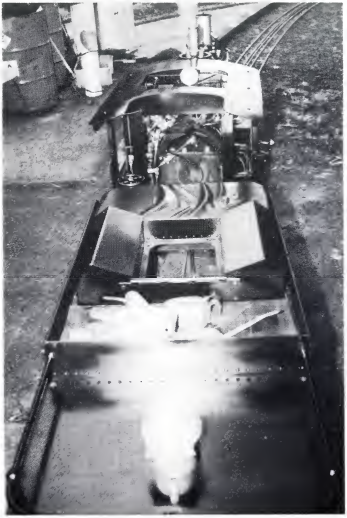
S.R.&R.L. No 24 continued from page 11...

The water tank was made from stainless steel and fitted inside the external shell. The tender bogies were made as per the prototype but fitted with roller bearings and steam operated brakes.

Finishing off

The project was completed in March 1996 after seven years of relatively heavy work. I thank my family for their valued patience and physical assistance with the countless rivets. No.24 was a delight ful project and I am very pleased with the way it turned out. There is no doubt that it meets my needs!

No.24 poses for the camera on its first outing.



A passenger's view of the "business end"
Photo: Brian Carter

Back Pressure in Pipes and Fittings

by Ted Crawford

Everyone knows that a small diameter pipe will have more back pressure than a larger one and can restrict the flow more than can be tolerated. But information about how much the pipework will influence the behaviour of the model live steam locomotive injector has not been published in terms with measured results, although the general rules have often been well expressed. These are; avoid sharp bends and use gentle curves wherever possible.

Understanding the figures

A bit later on some measured results of testing typical bits and pieces of a pipe system will be presented but first a few words explaining the significance of the figures will be helpful. One cubic foot of water contains 1000 oz and weighs 62.5lbs. The base pressure is 62.5 lbs per square ft.which, dividing by 144 gives 0.434 psi for a 12 inch head of watcr. Our highest pressure is 110 psi the same as a water head of 3041 inches and the probable lowest useful operating pressure is 20 psi or 553 inches of water head. These figures are quoted in inches so that the relative significance of the results (in inches of water head) can be judged.

An injector works by transferring the impulse or momentum of the steam to the water. At the high pressure limit the injector fails, not for lack of momentum but because of insufficient water being sucked in to condense the steam. On the other hand the low pressure failure is due to insufficient momentum for the usually excess water that is sucked in. Thus there is typically excessive available output pressure generated at the high pressure end of the working range and not enough at the low end. This means that the output system is most critical for back pressure in the low pressure region but a restriction in thc water input system will limit the high pressure operation, especially if the water is on the warm side. On the other hand some restriction to cause a reduction of flow is often used to enable the injector to work at low pressure.

But while an input water restriction can be helpful at low pressure and bad for high pressure, minimal restriction in the output which benefits low pressure can do no harm at high pressure.

The parameters

The system measured was based upon ¼ inch outside diameter, 3/16 inch inside diameter copper tubing. It was observed that the transition from the plastic large bore tubing immediately following the water head/back pressure gauge to the ¼ inch pipe gave a pressure drop amounting to a 7 inch head that did not reflect the pipe restriction so much as the effect due to the abrupt step down in inside diameter. The constant head of 7 inches was therefore deducted from all the other figures measured using ¼in pipes, as the transition in diameter is an internal feature of the injector, where the output cone is tapered to make a gradual transition in order to build up maximum pressure.

The results were measured at a water flow of 60 oz per minute. As the back pressure varies with the square of the water flow to convert to 40 oz per minute divide the given results by 2.25, for 30 oz divide by 4 and for 20 oz per minute divide by 9. For 80 oz per minute multiply by 1.8 but 5/16 tubing would probably be used for a flow of that amount.

Flow Test Results

Measured results using ¼in outside diameter, 3/16 inside diameter copper tubing at 60 oz per minute water flow.

Fitting	Head pressure
40 inches straight	39 inches of water head
12 inches straight	13 inches
6 inches straight	6¼inches
Boiler check valve(1)	16 inches
Boiler check valve(2)	36 inches
The effect of adding a 90 degree bend in the 6 inch length was:	
At ¾ in radius	1⅛ inches extra head
At ½ in radius	1¼ inches
At ⅜in radius	1¾ inches
Mitred 90 degrees	6 ½ inches
A ball valve was formed using ¼ inch ball in a 3/16 inch seat	
At 20 thou lift	79 inches of water head
At 40 thou lift	25 inches

For comparison, a brief test was done using 5/16 inch outside diameter, ¼ inch inside diameter copper tubing at the same flow.

Deducting the new reference, (1½ inches instead of 7 inches) a 12 inch length had only 5 inches of head back pressure compared with 13 inches for the same length of ¼ inch outside diameter tubing.

It will be noticed that the pressure drop per inch in the straight lengths varies slightly. This is probably due to experimental technique which was good enough for the purpose but not exact enough for a scientific study.

Check valve (1) had a good lift to the ball and a free flowing right angled exit. Check valve (2) was an in line type but the exit was of a form sometimes used, four saw cuts around the exit hole for the water to escape. Far better to use a cross pin to restrict the ball.

The figures for the ball valves show the disadvantage of using inadequate lift. Better to have a lift of half the ball diameter if this is possible. A small lift is said to be better for water pump check valves.

Consider a system with two bends of ½ inch radius and a total length of ¼ inch outside diameter pipe of 30 inches with a good check valve. The total of this would be 2 x 1 ¼+28+16=46 ½ inches At an operating pressure of 110psi this adds only 1.5% and even at 20 psi the extra is only 8.5%. Only by changing to a 5/16 inch diameter system would any significant advantage be gained.

On the other hand a bad check valve with inadequate lift and a saw cut type of exit waterway could easily double the figures. Even then the injector could still work well in the high down to medium pressure region. But the low pressure cut off may be raised by 10 psi or more.

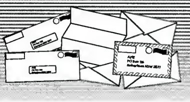
The input water flow is about the same as the output which also includes the steam but as already mentioned the effect of an input restriction is critical for high pressure and a minimum head loss should be aimed for. If the injector is used as a lifter then a size larger pipe is recommended than would be used where the input head is positive. Where possible the pipes should be as large as there is room for, but more than two sizes larger than the boiler feed pipe will not add much advantage.

Verification

To test your system find a short piece of plastic tubing which will fit over the tail of the output water connection to the injector and use this as an adaptor to tubing of 10mm inside diameter. Six feet or so of this size, a funnel and a jug of water will enable you to find the head needed to pass the rated water flow through your system. If more than 6 feet is needed then you have problems but if less than 30 inches then you have a very good system.

On the input side, test the flow through the pipework from the tank to the output nipple or tail where it connects to the injector. To get the best high pressure performance that your injector can provide, the required head for the rated flow should not be more than 6 inches Don't forget to keep the filter clean.

Letter Box



Transport problems solved

Sir,

I have been reading your excellent magazine for several years and enjoy immensely the many and varied articles.

There is, however, one thing which I have not seen covered although there may have been an article in an issue prior to the first one that I purchased. That is, how are model locomotives and traction engines safely transported from track to track. This is something which I have pondered over for a long time and not having come up with a satisfactory answer I decided to put the question to the experts. I know that some modellers use trailers or vans for their larger models but I have not seen just how they are fastened down to prevent movement or damage. Bearing in mind that many of these models travel interstate, there must be a simple solution or two.

Would it be in order for me to ask that experienced modellers give their solutions to the problem and so help out those of us who are about to begin building their first model and are contemplating visiting other club tracks?

Ian Macdonald

South Australia

What an excellent idea — this would be great material — any takers?... bmc

Propane in the workshop

Sir,

In response to the inquiry from Mr Geoff Howarth in the September-October issue in your Letter Box section on the subject of Silver soldering with Propane, I have been in the metal trade for over forty five years, and have used Propane for about thirty five years at home, and have had no trouble with the use of Propane as a substitute for Acetylene.

Welding with Propane alone does not work for the reasons you have stated, however, using Propane with Oxygen works in the same as Oxy/Acetylene, the only thing that Propane cannot do is achieve a carburizing flame like you can from Acetylene when hard facing.

The special welding/cutting torch kit acquired from CIG now known as BOC and consists of a mixer handle, 3 welding tips, cutting torch and tip, circle cutting attaclnnent, Oxy bottle gauge, Propane gas gauge, (suits the 9kg gas bottle), air and gas hoses, spanner and goggles.

I use this system in the production of my 5" gauge C38 class Pacific locomotive and tender and have used it from heating for shrink fits of the driving wheels to brazing diminutive pieces like the tender brake gearbox wheel and handle.

This kit is specially designed for Propane, and on inquiry to BOC Gases, Villawood, they do not have the kits made up, but they will make up a system to suit your requirements, however you will need an Oxy bottle, this set up is expensive, but the result is worth it.

I hope this has been of some help to you, Geoff.

William Parkes

New South Wales

No propane in the workshop

Sir,

Regarding Geoff Howarth N.S.W. Letter Box AME Sept-Oct. 1997 may I say to Geoff don't use LPG for anything else than the BBQ (but be careful there too) Most LPG heaters are larger by miles than Oxy-Acetylene heaters for similar puposes, N.B. I said most heaters not cutting tips, the LPG heater flame has a lower temperature than Oxy-Acetylene and this means it takes longer or the parts being heated to reach the desired brazing temperature and in this time a lot of the heat dissipates into the rest of the parts probably heating where not desired where with Oxy-Acetylene its suprising how small and hot a flame can be obtained with a No.8 Tip, less dissipation and more localised and quicker heating not forgetting to heat the opposite side of the article being brazed to of the operator. Geoff has the correct brazing flux and I assume silver solder of CIG easyflow or 245 or 246 type (old number) and I presume meticulously cleaned the pieces to be brazed without finger grease where he wants the braze. Oxy-Accetylene is more expensive for sure than LPG but is superior in that it can be used for a lot more operations and give a lot more satisfaction with the completed operation.

Kevin Bruderlin

New South Wales

More for propane

Sir,

In response to Geoff Howarth's request for help with silver soldering. His problem is likely to be that his flame is oxidizing instead of reducing.

BOC gasses have a torch made by Primus called Powerjet. It works well . Always enjoy the magazine and I hope this helps Geoff Howarth.

Julian Brown

Victoria

A sign of the times

Sir,

This Way To The Miniature Railway — Information is requested about this calico sign and the society or or group responsible for the genesis and operation of the miniature railway located "this way". The sign is obviously predecimal and possibly pre-1940. The painting was carried out by Nelson of Prahan. It is of indisposed condition and measures near to six by three feet. The miniature railway terminology may possibly refer to the table-top variety — and not the live steam type we are used to. This sign can be made available free-of-charge to the society who may have used it (if

Letterbox Contributions

Contributions of letters by mail to: PO Box 136, Robertson, NSW, 2577 or fax to: (02) 9646 1362 are very welcome.

As far as possible, AME is an open forum for all members of our hobby. Therefore, all expressions of fact or opinion — as long as they are not libellous — will be considered for publication.

Please **type or clearly print** your letters, as script is often difficult for the typist to interpret.

The Letterbox is a popular medium of expression, so space is limited. Therefore, letters of 400 words or less will have a better chance of being published.

bmc

they are still around) and can provide further details about their activities of that period and their current endeavours.

(All replies to The Editor, Australian Model Engineering).

David Mottram
New South Wales

Some hot air!

Sir,

I had intended to include this letter with my earlier one of 20th February, but there was an item in AME, Nov-Dec 1996, to which I wished to refer and, having got that magazine on one side, family had then carefully mislaid it for me!

I have constructed a Robinson B4 hot air engine — their smallest one — to 1/2 scale from castings imported from the Allyn Foundry in Wales about four years ago. It runs remarkably well — I enclose a photograph of it.

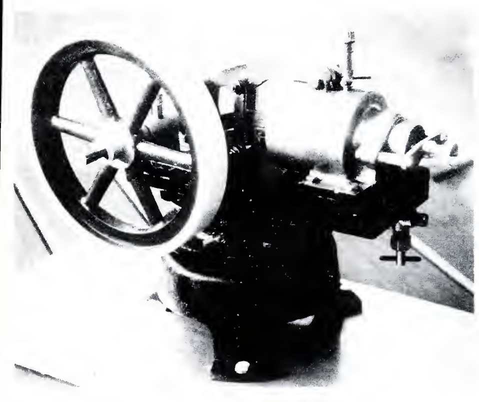
There can't be many of the Robinson hot air engines left — I have seen photos of two full-sized B4's published in *Model Engineer* in recent years. I know that they made a range of sizes, and that one in Photo 14 on page 14 of AME for Nov-Dec 1996 must be more or less their largest one. Their working is, as Dave Harper commented in his article, fascinating. I did not believe that hot air engines worked at all, which is why I set out first to construct the Robinson, then a Rider-Ericsson type, the latter using castings supplied by Camden Miniature Steam Services in Britain. That works very well, too. I enclose a photo of my Robinson.

Having constructed two satisfactorily working models of commercial types, and being convinced that the principle of the hot air engine does indeed work, I obviously had to educate myself in exactly how they worked, reading various books that I bought. At last it made sense. But what intrigues me is how the original design evolved - someone had to have a hunch! (Similarly, someone must have had a hunch to have thought out the principle, and got working, the first water injector for boilers. Think about it: as opposed to an air ejector, eg for a spray gun in which the pressure is positive throughout, in an injector you rely on the instant collapse of high pressure steam to provide a very high projective impulse to the water, sufficient to overcome the back pressure in the boiler.) I think that there is something analagous and diabolically clever about both concepts!

None-the-less, the principle of the hot air engine with a virtually sealed mass of gas oscillating from, and travelling to, hot and cold zones, alternately, and moved by a displacer piston in its cylinder, all providing useful power, seems real crazy! Even more so in the case of the Robinson where the air being displaced has to travel actually *through* the displacer piston, if it can thus be called in this case, as it consists of a can with *many* holes drilled through it at both ends, filled with brass wool in my case. The brass wool acts as a regenerator. This piston is attached to the spindle which goes down vertically from about 3/5ths along the beam, components which can be readily identified in Photo 14 above.

I had to be careful about the cooling water because it got into the displacer cylinder down where the displacer rod goes through the entablature - the thin horizontal hollow rectangular platform casting in the photo on which the upper works are mounted. The water vapour condensed in the live side of the power piston and rusted my careful machining! It was quite a mess. So my water is now piped into the entablature and out through a globe valve mounted on the top of the former - the enclosed photo was taken before I carried out this modification, although a photo at an intermediate stage, with a water tank, was published in one of the SMEE Journals sometime last year. I must admit to being highly curious about the running conditions of the commercial Robinson hot air engines.

Mike Thurgood
South Africa



Bringing in the youth

Sir,

I would like to pass on to the readers a few thoughts I've had about the lack of youth in our hobby.

Perhaps the following thoughts may invoke some discussion on the matter:

1) Instead of parents doing things as a family the parents go one way and the kids go with their friends in another direction.

2) The push from governments and business to computers to be the only thing to learn, as well as the hospitality industry, and none or little trade training.

3) The pressure bought to bear by their peers who are not interested in hobbies.

4) They believe that they must have a loco or want to build one, and either lack the hand skills or money and also couldn't afford to buy one either.

5) Not enough encouragement or giving-and-taking with the age group.

I believe with the first three we have no control over, but the last two we in the hobby can do something about.

Point No. 4. All clubs should realize that people are needed for station staff, safety, signalling, point duties finally but not least guards for the trains. So people who are keen should be encouraged to do these duties. Younger people enquiring about building locos should be told that the expense is dragged over a length of time so the cost is broken up into managable lumps.

Clubs should even look at buying machinery for people who can't afford them could come and use them under supervision. Because I also believe the reason why a lot of locos are not finished is because the people become frustrated because of the time it takes, as well as problems when building and they don't have someone they can turn to for help.

Point No. 5. I will cover by saying that the youth of today are bought up with different values. This is possibly a result of the influence of schools, the legal system, and by Government departments. The majority of people in our hobby have been bought up the old way and find it hard to accept the new way.

Because I work with the youth of today (apprentices) my understanding has grown and I believe you have to give-and-take, maybe a bit more give then take, things like how they speak and look. Encouragement, helping and talking, I have found that you can

earn their respect and they will listen as long as you speak to them properly (not down to them).

In doing this you will find the young will come around with maturity and your influence with a lot of respect for you, and this will give the club a member who enjoys the company of members who they trust as well as someone who is prepared to work hard for your club.

Noel Richards

New South Wales

Moving on

Sir,

On August 21, 1997, long time and Life Member and AMBSC boiler inspector for Penfield Model Engineers Society, in South Australia, Glen Brook, passed away peacefully at his home in Henley Beach, at the age of 62. Glen was one of the most generous and remarkable Model Engineers one could hope to meet. It is still difficult to accept that he will no longer be there to share a joke and his free laugh with us.

Despite the severe physical difficulties he experienced as a result of a catastrophic motoring accident some 41 years ago, Glen set about to thoroughly enjoy his hobby, his life, and good company. Always ready with a smile and encouraging words, Glen's determination to produce reliable, honest creations provided the inspiration for many would-be model engineers — and he provided further help to keep them on track. As with the passing of all senior model engineers, Glen's departure will see the dimunition of yet another parcel of knowledge, possibly, never to be recovered.

Glen never found the time to settle with a wife and family, but was welcomed by the families of all of his friends as one of their own. His relationships with his model engineering nephews, the sons of his late, and fellow model engineer brother, Rex, was particularly close.

The greater family of model engineers who knew Glen, are poorer for his passing. His modelling legacy and our fond memories will ensure that he holds a special place in the hearts of those who held him dear. On behalf of his friends at Penfield Model Engineers Society, and all other Australian Model engineers, rest in peace, good mate. We are proud to have been your friends.

Barry W. Walding

South Australia

To Terry

Sir,

I am sad to report that we have lost another member to cancer in August. Terry Moore's train life started with the Western Districts Club at Fairfield before he and his family moved further north and joined the Central Coast Steam Model Co-Op Ltd.

In the years that he was with our club you could depend on him to be there, even when he was really sick he would still come along and run his 27 class for the club. If anyone required guidance or help he would be there offering the use of his machines and also encourage them to do their best.

Terry was a good Club member he and his wife Jean re-designed our club magazine so the club could save cost in mailing out. To Terry the club was his second love after his family.

He will be sadly missed from the Hobby.

Noel Richards

New South Wales

More excitement please

Sir,

Some years ago (May '94) I became an enthusiastic subscriber to AME believing that it would be a forum for the exchange of miniature engineering technical information, experiments, development and testing of new ideas, etc.

However, a few observations from over the years are that the magazine is heavily into:

1. The social aspects of club activities
2. Lots of photos
3. Locomotives, locomotives, locomotives
4.Some very dated and simplistic technical articles (the 422 being an excellent and notable exception)

Okay, if that is what it takes to publish a successful magazine, so be it.

I believe, however, that there is a group of engineers somewhere out there who would enjoy a bit more meat with their engineering diet!! To this end I have inserted a classified advertisement in the Sept-Oct '97 edition, offering free of charge an original design and technical paper to test this interest. I have another five designs and technical papers prepared to stimulate further interest, if warranted.

My hero at the moment is a young engineer, Kurt Schreckling, whom I discovered in a recent visit to Europe. He has designed and built a miniature gas turbine for model aircraft which fly successfully. The rotor of this unit spins at an incredible 70,000 rpm. This guy is at the cutting edge of miniature engineering. An exciting place to be for me — what about other Australian engineers?

Bob Weir

Bob, strange as it may seem there are many Australian model and experimental engineers who savour the finer points of the hobby. I have seen a many innovative designs and witnessed one of the finest acheivements in model engineering that I have ever seen. However, as I am regularly reminding our readers — the magazine content is totally at the mercy of the contributors — what you see is what we get!... bmc

Workin' on the railroad

Sir,

I would like to build a 5" gauge track on our property. Being close to the ocean, rust could be a problem, can you suggest the following:

1. Aluminium or steel rails. I can weld steel, have power hacksaw, oxy and arc.
2. Bolt with spaces (tube) rails or weld to steel sleepers, use timber sleepers?
3. Roadbed?
4. Rail size considering distance from any convenient source, everything has to be brought in new. It will not be for public i.e., heavy traffic running.
5. I have seen club tracks some are great (for me overkill) but for frequent use necessary.
6. Point design and curve radii, sleeper spacing ease of maintenance any other help please.

Will pay for any photocopies of designs, I have not been able to locate any so far. Cost effective, quick to build, lasting, attractive and fun. I Have to run the *Blowfly* on something other than the bench.

Perhaps an article for the home builder?

D. Cleburne

New South Wales

Thanks for the note, we actually have a few articles on track construction almost ready for publication. However, if any reader wants to help out I will pass on any mail... bmc

Workshop tooling

Sir,

I have just discovered AME and I am impressed to the extent of the covereage. I enclose a cheque for a subscription.

My main interest is workshop equipment, therefore I have contacted Hobby Mechanics to obtain literature on their products. I would like to contact any reader who has made either the dividing head or the Qourn tool and cutter grinder. Any help would be appreciated.

Thank you for an excellent magazine.

Arthur A. Arnold.

Tasmania

Wire service

Sir,

Would any reader be able to inform me as to where I might be able to purchase 2 to 4 metre lengths of 0.04 inch diameter (or close to) diamond-hard/cold drawn spring (piano or music) wire. I would also like information on where to purchase Barium Chloride Salts.

Douglas Hall

Queensland

You can send your Letter Box contributions via e-mail to: ame@ameng.com.au

News Desk

compiled by Brian Carter

Welcome to our tenth anniversary issue. We have seen many positive changes to the hobby since AME began in October 1987. With this issue I say farewell as Managing Editor and welcome David Proctor who will continue the magazine as Managing Editor with the January issue. I'll be having a well-earned rest from magazine deadline pressures, but will continue with advertising liaison and minor background roles.

I would like to take this opportunity to thank the many support crew who have put up with me for the past four years. Without those who toil away in the background, you wouldn't have a magazine at all! I would also like to thank Trevor Ryan from The Area News who has often gone out of his way to make sure the magazine comes out right. Trevor was very helpful with advice when I first started out. A special thank you to you, our readers, without whom there would be no magazine. Your support over the last ten years has been outstanding.

To one and all a Merry Christmas and a Happy (and steamy) New Year.

Traction Engine Register

I have had a request from Gordon Blake. Would anyone who has an interest in traction or road vehicles please call Gordon on (02) 6722 4272. Gordon has been maintaining a register of interested traction modellers for several years but it has become out of date with moves etc. Please call even if you think you are on the list already.

Article ideas

One club is looking around for ideas on braking systems for passenger cars. If your club has adopted any kind of "braking standard" perhaps you could send AME some details so we can put an article together to explain all the options available.

A posting in the Letter Box suggested an article on a variety of methods used by modellers when transporting and securing their models for travelling to thier home track or invitation runs.

Advertisers

AME has received a lot of support from advertisers over the last ten years. Without whom we would be very restricted or non-existent! Please support our advertisers, especially with Christmas looming... how about Christmas gifts for your friends.

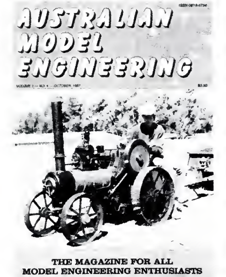
A new advertiser, Golden Years Collectable Cards (see back page) have a collection of 16 postcards. Each has a *different* print from the works of Kenneth G Bowen. Excellent value and ideal to send Christmas greetings with a unique railway theme.

Another new advertiser Gregory Williams Photography, have a great collection of vintage machinery videos. I bought a couple to have a look at and I was very pleased with the quality.

If you are planning to visit the UK during 1998 have a look at the ad from Harvey World Travel on page 63 first.

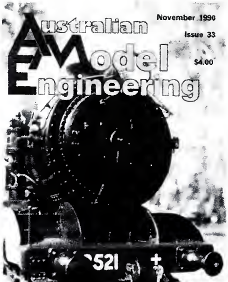
Don't forget all the others though.

A quick look at the development of AME



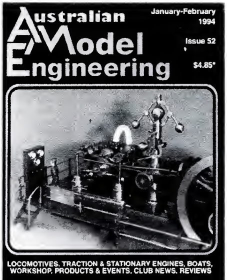
Issue number 1 appeared in October 1987. The Editor was Mark Whittaker who, with two friends, Gerardus Mol and Walter Shellshear comprised of the first AME team. The magazine was only available by subscription and from a few specialist hobby shops. The circulation at that time was about 900 copies.

Mark carried on for three years when, without warning, decided to cease AME production. The final, issue 32, went on sale in May 1990. However, some wouldn't let it go quietly...



A rescue mission was conducted and AME was purchased from Mark Whittaker by a larger and more determined team. Neil Graham led the team as the first re-vamped AME issue 33 went on sale in November 1990.

The magazine format was changed to the larger A4 size and in-house typesetting was introduced. AME was made available through newsagents as well as subscriptions etc. Circulation began at around 3000 copies.



A change of occupation for Neil meant a change of Managing Editor. Brian Carter took over the role from issue 50, September 1993.

The current cover design was introduced from the January 1994 issue. Several layout changes were also introduced over subsequent issues. With the current issue, circulation is now around 6000 copies world-wide... and still growing!

Classifieds

Hercus Lathes For Sale

- **1**. Hercus Model AR. 4½" c.h x 21 b.c. on cabinet, new single phase motor, new 3 jaw and 4 jaw chucks, drill chuck, in excellent condition, for $3800.00.
  2. Hercus Model A, 4½" ch x 21" b.c. on cabinet, 3 ph motor, 3 jaw chuck only, good condition, for $1600.00. Contact J W Lowe, 44 Dartford Rd, Thornleigh 2120

7¼" gauge loco for sale

- Live steam Atlantic Loco (Maisie) craftsman built to ¾ complete, rods, firebox ends & plans. Tender completed $6500. Contact Jan on (02) 9484 3259 or leave message if unanswered, or
  Fax. (02) 9484 4892

7¼" Pacific Loco for sale

- 4-6-2, Copper boiler. Piston valve engine. $12,100. Also 7¼"g *Heidi 2* 0-4-2 Loco $8,000. Ring (02) 6686 4000 or write to:
  W. Heard. 1 Riverside Dr, Ballina 2478

5" Simplex for sale

- Has been stored 10 years, but refurbished runs and pulls well. Current AALS Certificate $3,300 ONO.
  Phone John (03) 5595 1430 Cobden Vic.

Chime Whistle For Sale

- Three-note full-size $400. Phone Bob Brown (08) 9399 1902

3½" gauge Loco for sale

- LNER Mogul Copper Boiler, complete Brass Tender injectors 2-6-0. $2,100 ONO Phone Michael (02) 4938 3494 after 6pm.

Miniature railway for sale

- 7¼" gauge over 1000 metres of track, locos, riding trucks extra steel, sleepers at 12ft turntable and 2 bridges. $20,000 Strathalbyn Phone Rod Muller (08) 8536 2489

5" gauge *No 1 Rail Motor* For sale

- 0-4-0 Steam Locomotive with ride on tender. 1¼" bore 1½" stroke, Walschaerts Valve Gear, 100 PSI Copper boiler. Super heated, with 3 year AMBSC Certificate. The comfortable ride on tender has a 9 litre water capacity, two roller bearing bogies and lever operated disc brakes. This locomotive was carefully built over 4 years by the owner and is a good steamer in excellent condition. Price $5,500 Phone Bert (02) 9529 9937

5" gauge 0-6-0 Pannier Tank For sale

- In excellent running order with features too numerous to mention. Copper boiler certified to 6/2000. Includes Pullman type riding carriage which seats up to 5 persons. $5,500 ONO
  Phone Barry (08) 8248 4843

Classified rates

- $3.50 per line as published (including heading).
  Don't send payment with ad, we'll invoice you after publication. No limit to the number of words.

Subscribers Free Market conditions

- Non-commercial only, at the publisher's discretion.
- Maximum of twenty words, including your contact name, phone number or address.
- Posted, on special form provided. No faxes please.
- 5" gauge or larger locomotives (for sale) are not eligible.
- Only one entry per issue.

3" scale Allchin *Royal Chester* T.E. For sale

- Built to S.A. DLI in 1988-89. Steel loco boiler with full wet back and drop out grate/ash pan. Is now fully "converted" to AMBSC Boiler Inspection, with certificate. Photo see July 1997 AME page 34. Complete with two 6 position (children) riding trucks.
  Sorry to see her go but can't drive 3 T.E's at once. Price $15,990 + delivery anywhere in Australia. Ph John Levers (08) 8287 0970

LBSC's *TICH* 3½" gauge For sale

- Approx 40 castings, copper for boiler, boiler partly built. Castings partly machined. Book on how to build *Tich* included $500.
  Phone Vern (03) 9874 1478

Chequer Plate Clearance Sale

- 5" gauge true-to-scale chequer plate in brass, aluminium and steel. It will never be rolled again. For sample and prices send SSAE to C. Christensen, PO Box 246, Blackheath, NSW, 2785

Lathe parts and information wanted

- For a Parkinson bench lathe model SA-BL1 flat belt drive type. Parts from a similar type Hercus might fit, anything at all considered. Phone Roger (02) 6297 9446

ADEPT lathe Wanted

- Any condition, phone Phil (02) 9876 5723 nights.

Subscribers Free Market

FOR SALE

Electric motor to suit a Quorn Tool and Cutter Grinder $50.00 plus postage. Phone Steve (02) 6351 4627 evenings.

6" Parabolic mirror, diagonal mirror and eye piece $350 Phone Ian (02) 9543 1222

WANTED

Locomotive, steam car parts in any condition or information which may lead to them. Phone Colin Wear (02) 4997 4838

Buy or borrow, copy or photocopy of "Loco Profile No. 7 (Rockct)" by Brian Reed. Phone Geoff Marshall (03) 6267 5001

SWAP

P & N Power hacksaw blades 11 off 16" x 1¼" x 10 teeth new high speed steel for same only 14" long. Phone Morry, 051 742109

Magazines Live Steam, Model Engineer, Junior Mechanics. Sell or swap. R Henderson 8 Jacaranda Ave Bendalong. (02) 4456 1333